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Engineering and Contracting

Devoted to the Economics of Civil Engineering Design and to Methods and Costs of Construction

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Roads and Streets—1st Wednesday
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks (c) Irrigation and Drainage
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Railways and Excavation—3rd Wednesday
(a) Excavation (c) Quarries and Pits
(b) Management and Office System (d) Steam Railway Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings (d) Miscellaneous Structures
(b) Bridges (e) Properties of Materials
(c) Harbor Structures (f) Management and Office System

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Why Does Street Paving Lag Behind Road Paving?

For the past six years or so street improvement has not kept pace with road improvement, and each year witnesses a growing discrepancy between these two classes of highway improvement.

It is certainly peculiar that where good pavements are most needed, namely, in cities, they are becoming the least common. How frequently are we reminded of this anomaly when we cross the city limits and trade a smooth ride over a country road for a rough ride over a city street. How often do we complain of the congestion of certain well paved city streets, and bewail the surface condition of streets parallel thereto.

Most of us do not attempt to find the fundamental cause of this surprising and regrettable inferiority of the average city street. We accept it as a matter of course, just as we accept our taxes—a thing to be damned but to be endured.

If we are civil engineers we know what should be done to keep the city streets in repair, but we are apt to regard it as being no concern of ours to tell the public what should be done. We wait quietly for some other class of citizens to take the initiative. Then when the money is appropriated we are prepared to direct its expenditure. But why should we remain thus inert as to the raising of the funds needed for street improvement? Must engineers forever be fearful of taking the initiative outside their purely professional activities? Fortunately, a great many engineers will reply in the negative, but unfortunately most of those will virtually negative that reply by doing nothing. We engineers have yet to get past the age of criticism into the age of active propagandism. We are still prone to wait for promoters instead of becoming promoters ourselves.

To promote street improvement most effectively it will be necessary first to change the laws that govern the raising of money for such improvements. Practically all money for street improvement is now raised by taxing property that faces the street. This is economically as unsound as it would be to raise all money for railway construction by taxing the farms facing the railway right of way. Indeed it was this very economic blunder that held back road improvement in America for scores of years. It was not till New Jersey, in the early nineties, passed a state aid law that any state began to get an adequate mileage of improved roads. So long as the farmer whose property was "improved" by a road was required to carry the entire burden of the improvement, there was universal opposition by farmers to adequate improvement. The very same condition exists today in our cities. City property owners, and particularly those who lease their property, usually resist adequate street improvement. Why should I pay for a pavement that is used a hundred or a thousand times as often by other men as by me. This is the constantly reiterated query whose answer spells inadequate improvement of city streets.

It is not altogether a simple matter to devise an equitable means of raising money for street improvement, particularly where a large percentage of the streets have already been improved by taxes upon abutting property. But surely engineers are ingenious enough to devise a better plan than the one now prevalent.

There seems to us to be no insuperable difficulty in so adjusting taxes as to encourage adequate street improvement. Probably one-third of the cost should be assessed against abutting property, one-third against all property, and the remaining third raised by a tax on gasoline. Property facing streets already well paved should probably not be required to pay that part of the general tax used for further street improvement. Bonds should be issued, and retired in about 20 years from the taxes thus raised; for it is an economic mistake to make the average taxpayer pay the entire cost of a pavement at one stroke. The argument that a bonded debt increases the ultimate cost of an improvement is sophistical, for it fails to take into account the ability of the taxpayer to invest the money that he would otherwise be required to pay out. Thus, if your assessment were $100 for the pavement in front of your lot, you would pay $100 in interest at 5 per cent over 20 years plus the $100 principal at the end of 20 years, or $200; but during that 20 years you would have had the use of the $100, and could have realized at least 5 per cent annually thereon by buying bonds, so that the interest thus carried would pay the interest on the street bonds. The fact is that many taxpayers can use their money so as to earn more than bond interest, and for all such it is a positive gain to defer payment on street improvement. In short, no one need be worse off by bonding for street improvement, and many will be better off because of their ability to earn more than a bond interest rate.

It is true that deferring payment by borrowing occasionally leads to excessive borrowing, but such excesses can be prevented by legal restrictions. Indeed these very restrictions are now so severe that they are frequently one of the causes of inadequate expenditure for municipal improvements.

There has been not a little recent talk by prominent bankers and others who have decried the tax exemption feature of municipal bonds on the ground that it is leading to excessive expenditures for city improvements. While we do not favor such tax exemption, we must insist that, up to date, municipal improvements in general and street improvements in particular have not kept up even to the poor prewar standard.

Statistics show that, after making proper allowance for increased wages and prices, municipal bond issues have been proportionately less per capita during the last 7 years than they were before the war. Evidently, then, tax exempt "municipals" are to be classed among the financial bugaboos with which some bankers are fond of trying to frighten the public. It should not be overlooked that many of these bankers and brokers specialize in marketing industrial and utility securities, and that they are speaking several words for their own pocketbooks when they seek to curtail the issue of municipal bonds in order to increase the marketability of the classes of bonds that they handle.

The 16th Birthday of Engineering and Contracting

On the first of January, 1906, Engineering and Contracting (then named Engineering-Contracting) began its existence. For three issues it appeared as a monthly magazine; then it was consolidated with Contract News, a weekly periodical 18 years old, whose volume number was adopted. A year later Engineering World was consolidated with this journal, and two years thereafter The Dirt Mover was absorbed.

In its relatively short life Engineering and Contracting has experienced two severe industrial depressions—the "panic" of 1907 and the "hard times" of 1920-21. The country is now emerging from this last business depression, and there is every reason to expect several years of steadily increasing prosperity.

Immediately after the close of the Civil War in 1865, there was a rapid fall in prices and a short business reaction. Then came an era of unprecedented construction activity which did not end till the panic of 1873. That prosperous period was especially noteworthy for the large mileage of new railway construction. Were it not that our railways have been financially starved by 15 years of inadequate freight rates, there would doubtless be a repetition of the history of 1865 to 1873, for the country is sorely in need of improved railway transportation. Probably half the railways in America could be electrified with profit. But investors are afraid to furnish the capitol for fear that the profits from such improvements would be largely confiscated by the Interstate Commerce Commission, which, up to the present, has shown no inclination to let the average railway earn more than 6 per cent on the capital, invested. There is some evidence, it is true, of a more liberal public attitude toward railway investors, but it may take several years to reach the point where the public will look with complacency upon railway profits that are more than half what the average manufacturer, merchant or banker earns.

If railway construction is thus crippled, it is not so with road construction. In the highway field, we see an activity that bids fair to give to the next ten years the title of the great road building decade. With ten million motor vehicles already in use, and the number increasing at an astonishing rate, it is not to be marveled that at last America has begun to pull herself out of the dust and the mud.

Sixteen years ago, when this journal began its existence and its advocacy of Federal Aid in road building, there was an almost infinitesimal mileage of hard roads outside of cities. In our advocacy of Federal Aid we were opposed by such magazines as Engineering News, Engineering Record, and Good Roads Magazine. Federal Aid was called "paternalism," and it was argued that Federal appropriations for highway construction would result in "pork barrel" wastage of public funds. All such opposition has vanished. The other day Congress appropriated $90,000,000 to be spent on road construction during the next 18 months. Of this sum $15,000,000 is for "forest roads," and the balance is for "state aid roads."

We predict that during the next 10 years the Federal government will average $200,000,000 appropriated annually for roads. Good road advocates may well urge that the money saved by restricted naval development be expended for increased highway development. When the 25th birthday of this journal arrives, we hope to be able to point to a verification of this prediction, even as we are now able to say that our predictions of 16 years ago have come true as to large scale support of the Federal government in road building.

What Does "Pure Science" Mean?

A word or term means what it is commonly taken to signify, unless there is an agreed upon change of signification. Scientists are constantly introducing changes of meaning of common words, partly because the growth of knowledge begets the necessity of new meanings corresponding to new discoveries, and partly because it is desirable to retain old words for new uses in order not to repel readers by the execessive use of coined words. Has the time come when the term "pure science" should be given a new meaning? We think so. The reason for a change of definition is not merely the present lack of common agreement as to what is "pure" in science, but the desirability of removing the prevalent opinion that "pure science" is science that is distinguished by its uselessness.

The old toast of the professors of mathematics, "Here's to pure mathematics; may it never be any use to any body." seems somehow to have become attached to all "pure science." This is greatly to be deplored, for, aside from the men who search for new knowledge merely for the love of searching, the vast majority of men are interested only in the kind of knowledge that can be put to use. Since pure scientists depend for their support upon men who apply science, it would seem the part of wisdom for pure scientists to change the meaning of the term "pure science" so as to avoid the appearance of asking for support for a useless sort of work. The world is not fond of paying for other men's pleasures, but will gladly pay for what will add to its own.

The expression "pure science" probably owes its origin to the early distinction between pure and applied mathematics. If we reflect a little, we see that aside from the processes of arithmetic and of higher mathematics that facilitate ascertaining the number of units in different groups, there is no really pure mathematics whatever. Even geometry is the application of these processes of enumeration to problems in spatial relations. And geometry in turn is applied to surveying, navigation, etc. Such reflection leads us speedily to the rather startling conclusion that the degree of "purity" of a science is not measured by the infrequency of its application to practical affairs, but that the "purity" is really proportional to the practical uses of it. The processes of addition, subtraction, multiplication and division, for example, above all others are the purest of pure mathematics. Why? Because they are not frequently useful? No, because they are the most widely useful of all the processes of mathematics. And by a similar inspection of the various branches of pure science we are led to this generalization: The degree of purity of a science consists in its degree of generality, that is in the extent to which it may be applied.

By this criterion we conclude that pure mathematics is the purest of all the sciences, and therefore the most widely useful. "Purity" and utility in science thus became synonymous. This assuredly is a conclusion quite at variance with the prevalent conception of pure science, and it is a conclusion that should be given the widest publicity if we are to advance industrially with great rapidity during the next century.

Writers and Other Specialists

Whenever an editorial is published in a daily paper on a subject in which you are very well informed, you will usually find yourself in disagreement with some, if not all, of the editor's conclusions. Did it ever occur to you that every other specialist finds the average daily paper editorial on his specialty equally erroneous? And did you ever stop to consider that every branch of human knowledge is somebody's "specialty"? If a non-specialist is usually incapable of reasoning soundly on a subject that is a "specialty," and if all subjects are "specialties" when properly treated, it follows that no one but a specialist can be trusted to express any opinion on anything. This seems an extreme position to take, yet it is not far from the truth. Indeed it expresses the truth completely wherever human knowledge has reached the scientific stage in any of its departments. It is only because so much of our knowledge is very fragmentary and unsystematized that one well-read man is occasionally as much entitled to an opinion as another.

Already there are signs that newspaper editors are beginning to realize their inability to discourse wisely on any and every theme; most of them are featuring articles by writers who are "specialists." Yet the average editor is still a long way from realizing that every subject is susceptible of being treated as a specialty. Witness the popularity of such syndicated editorials as those of Dr. Frank Crane, whose pen is more versatile than nature herself. Here is the typical newspaper editorial writer outrunning his type. His wisdom is as wide as the oceans, albeit no deeper than a frog pond and quite as muddy when stirred. His is the faculty to wield words interestingly on any subject, because his vocabulary is great and his imagination greater. Such a writer needs no facts to be interesting, for his average reader is quite as destitute of facts as he, and enjoys the slight strain upon his attention while he gazes from the balloon of the editor's fancy upon the world of the editor's fancy below.

Perhaps a few generations hence some writer on logic will collect the editorials of Mr. Arthur Brisbane, Dr. Frank Crane and Fra. Elbertus (Hubbard), as specimens of how much can be said speciously upon every specialty by men who specialize in nothing save talk.

Of course the world demands entertainers, and always will demand them and pay them well for the entertainment. But in the course of time—possibly an aeon or two—the world will distinguish between its entertainers and its instructors. At present many of the entertainers pose as instructors—"and get away with it."

The moral appears to be that the real instructors—the specialists—should either study also the specialty of entertaining, or should form partnerships with literary entertainers, letting the latter tell interestingly what the former tell correctly.

Officers of American Association of State Highway Officials. At the 7th annual meeting of the American Association of State Highway Officials, at Omaha, Dec. 5 to 8, the following officers were elected: President, C. M. Babcock, commissioner of highways, Minnesota; vice president, C. J. Bennett, highway commissioner, Connecticut; secretary, C. M. Upham, state highway engineer, North Carolina; treasurer, F. T. Sheets, superintendent of highways, Illinois. Executive committee: W. D. Uhler, chief engineer, Pennsylvania, 1926; D. P. Olson, director bureau of highways, Idaho, 1926. Members of the executive committee whose terms hold over are: George P. Coleman, chairman, state highway commissioner, Virginia, 1922; Paul D. Sargent, chief engineer, Maine, 1922; Ira R. Browning, Utah, 1923; R. J. Windrow, state highway engineer, Texas, 1923; Geo. E. Johnson, secretary, department of public works, Nebraska, 1924; Thomas H. MacDonald, chief, Bureau of Public Roads, 1924; Austin B. Fletcher, director of public works, California, 1925; W. R. Neel, state highway engineer, Georgia, 1925.

Physical Science Explained: A Book on the Interpretation of Our Environment

By F. E. McDONALD,

Assistant Professor [illegible] College of Engineering,
New York [illegible]

Most textbooks on physics are dull treatises compiled by the kind of scholar that Carlyle called dryasdust. These books plainly are written merely to prepare students for specializing in the subject. As a matter of fact very few students specialize in physics; on the other hand, many ordinary people would like to acquire a knowledge and explanation of the physical phenomena about them. The ordinary man 10 years out of college remembers very little of the courses in physics that he once studied. Perhaps he has a vague recollection of a few experiments performed mechanically and never really understood, or of "problems" solved blindly by substitution in formulas that he used because the book said to or because the student next him used them. Yet a knowledge of physics is important in everyday life, particularly to engineers.

An excellent book on physics, or general science, is "Everyman's Science" (Hinds, Hayden & Eldredge). The author is Dr. Daniel R. Hodgdon, president of Valparaiso University, formerly a teacher of science. This book is skillfully and clearly written in an interesting and non-technical style. Once opened it is difficult to close, for the explanations of things that we have noticed all our life but never have reasoned out or had lucidly explained to us invite and fascinate.

The first chapter, for example, discusses the moisture in the atmosphere. It tells why we should keep a pan of water in a heated office or living-room during the winter; why a hot bath in summer is more cooling than a cold bath; and why a dog's nose is cold. The second chapter explains that fogs and clouds are the same phenomena, differing only in altitude; and that a "mackeral sky" means warm, wet weather.

The third chapter shows why water gurgles from a jug; how a boa-constrictor uses atmospheric pressure in swallowing its food; and how the action of spiders, leeches, and frogs foretells the weather. The fourth chapter, which is on heat, explains the shiny surface of thermos bottles and the dark, rough surface of radiators; it recommends copper kettles as requiring less fuel than iron kettles because the thermal conductivity of copper is 90 while that of iron is only 14; and it compares heating systems for buildings. The fifth chapter, also on heat, explains why the Fahrenheit thermometer has its zero at a point 32° below the freezing point of water; and why plumbers do not use a piece of lead to mend a lead pipe.

The sixth chapter takes up fuel and ventilation, the seventh chapter takes up food and medicine; the eighth chapter tells facts about water and water supply; the ninth chapter discusses germs and the germ theory of disease. In the tenth chapter, which is on light, are discussed lenses, the eye, and illumination. Electricity is taken up in the eleventh chapter; sound and music are treated in the twelfth; and various laws of physics and mechanics are treated briefly in the last three chapters of the book. All these subjects are treated in their everyday manifestations, just as the ordinary man comes in contact with them in ordinary life.

The scientific truths discussed in this book have aroused the curiosity of man since he first began to wonder about the strange world in which he found himself. To learn these laws of nature, philosophers and experimenters have been reflecting and observing for thousands of years; and many of them have been neglected or even punished for their pains. Today we can buy a book that explains the whole business, and we can sit and read it without any more trouble than eating our dinner.

Michigan Lets 259 Road Contracts in 1921.—According to a summary compiled by F. D. Messenger, Road Engineer of the Michigan State Highway Department, the department last year let 259 contracts for road building. The contracts were awarded as follows: January, 9; February, 3; March, 27; April, 35; May, 50; June, 40; July, 12; August, 57; September, 8; October, 7; November, 8, and December, 3. According to the outlined plans for the department, it is expected that the peak for 1922 will be reached at least by the month of May.

The Chicago Good Roads Congress and Exposition

Many questions pertaining to highway finance and administration as well as road construction and highway transportation will be discussed in the light of more recent developments at the big nation-wide good roads congress and exposition of road-building machinery, materials, methods and appliances to be held at the Coliseum, Chicago, Jan. 16th to 20th, 1922, under the auspices of the American Road Builders' Association.

The program of addresses, prepared papers and discussions covering the several sessions of the congress will include such subjects as the following:

Detailed technical discussions by recognized authorities on the latest methods evolved in the construction of all types of paved thoroughfares including the Portland cement types and the asphalt or bituminous types, as well as brick and granite block, gravel and dirt roads and the construction of bridges and culverts. Fall letting of road contracts as a means of speeding up highway construction and thereby relieving not only seasonal unemployment, but seasonal congestion in the delivery of road materials and supplies.

Results of the more recent research investigations by the U. S. Bureau of Public Roads and the Highway Research Committee, Division of Engineering, National Research Council.

The development and future of highway transportation and its relation to highway improvement. One entire session will be devoted to the various phases of these subjects.

The present and future of Federal Aid to the states in financing highway construction, and national and state road problems, both in the administration of highway departments, and the construction and maintenance of the roads themselves.

An exhaustive discussion by financial experts on the best method of determining the proper procedure in highway finance, obtaining local legislation, floating local bond issues and disposing of the bonds.

The simplification of specifications and the promotion of better relations between public officials, highway engineers and contractors.

The exposition of labor saving machinery, materials and methods will open at the Coliseum, Jan. 16th, at 8 p. m., and will surpass in the number and variety of its exhibits the great exposition of last year. At the first drawing of space held in New York on Oct. 29th, 1921, all records for the reservation of space were broken, practically the entire first floor of the exposition hall and annex being assigned. The extraordinary demand for space has necessitated the rental of buildings adjoining the Coliseum to house the overflow. Many firms which, heretofore, have never exhibited at the national good roads show have engaged space. The exhibitions will not only include practically every known kind of machinery, appliances and transportation equipment identified with highway construction, but will include many new inventions. An interesting feature of the show will be an exhibit by the U. S. Bureau of Public Roads, for which 2,000 sq. ft. of space will be necessary, as well as complete exhibits dealing with road construction by the Asphalt Association, the Portland Cement Association, the National Association of Paving Brick Manufacturers and other similar organizations that will give demonstrations of the latest methods in laying their various types of pavements.

The tentative program of the congress is as follows:

PUBLIC SESSION.

Invocation.

Announcement of convention committees.

Address of Welcome on behalf of the City of Chicago by the Mayor.

Response on behalf of the American Road Builders' Association by the President.

SESSION DEVOTED TO BITUMINOUS ROADS.

"Bituminous Foundations," Hugh W. Skidmore, C. E., Chicago Paving Laboratory.

"Selection of Bituminous Wearing Course," C. M. Pinckney, Chief Engineer, Bureau of Highways, Borough of Manhattan, New York City.

"Utilization of Local Material for Mineral Aggregate," Major W. A. Welch, Chief Engineer, Palisades Interstate Park Commission, New York.

"Asphalt Specifications," L. M. Law, Chief Chemist, New Orleans Refining Co.

"Specifications of Mineral Aggregates," Roy M. Green, manager, Western Laboratories, Lincoln, Neb.

"Controversial Construction Requirements in Specifications," Bruce Aldrich, Toronto, Canada.

"A Simple Graphic Method of Proportioning Sands for Sheet Asphalt Mixtures," Provost Hubbard, Chemical Engineer, The Asphalt Association, New York City.

SESSION DEVOTED TO PORTLAND CEMENT CONCRETE ROADS.

"The Selection of the Mineral Aggregate for a Portland Cement Concrete Road," John H. Mullen, Chief Engineer, State Highway Department of Minnesota.

"Design of Concrete Roads for Heavy Traffic," W. D. Uhler, Chief Engineer, Pennsylvania State Highway Department.

"Inspection and Control of Materials for Concrete Roads," R. W. Crum, State Testing Engineer, Iowa State Highway Commission.

"Importance of Surface Finish and Methods of Control," H. E. Breed, Consulting Engineer, New York City.

"Single Track Concrete Roads for the Average County," P. C. McArdle, County Highway Superintendent, Vermilion County, Danville, Ill.

"Pavement Widths for Highways Serving Large Cities, Edward N. Hines, Chairman, Board of County Road Commissioners, Wayne County, Detroit, Mich.

SESSION DEVOTED TO COMMON ROADS.

"Common Roads," T. J. Wasser, State Highway Engineer, Trenton, N. J.

"A Systematic Study of Gravels for Road Purposes," Wallace F. Purrington, Chemist and Testing Engineer, New Hampshire State Highway Department.

SESSION DEVOTED TO HIGHWAY FINANCING.

"The Proposed Wisconsin Plan of Highway Finance," A. R. Hirst, Chief Highway Engineer, Wisconsin Highway Commission.

"The Minnesota Experience in Highway Financing," C. M. Babcock, Commissioner of Highways, Minnesota Highway Department.

SESSION DEVOTED TO HIGHWAY TRAFFIC AND HIGHWAY TRANSPORTATION.

"Truck Overloading, Its Relation to Road Construction and Maintenance," J. G. McKay, Ph. D., Professor of Economics, University of Wisconsin.

SESSION DEVOTED TO HIGHWAY RESEARCH.

"Highway Research," W. K. Hatt, Professor of Engineering, Purdue University; Director of Research, National Research Council.

"The Illinois Experimental Road," Clifford Older, Chief Highway Engineer, Department of Public Works, Illinois.

"Highway Researches and What the Results Indicate," A. T. Goldbeck, Chief, Testing Division, U. S. Bureau of Public Roads, Washington, D. C.

"The Highway Outlook," Thomas H. MacDonald, Chief, U. S. Bureau of Public Roads, Washington, D. C.

"Cost Keeping on Highway Construction," A. R. Losh, Assistant Bureau of Construction, U. S. Bureau of Public Roads, Washington, D. C.

"Development of Small Stream Valleys Into Traffic Routes," Jay Downer, Chief Engineer, Bronx Parkway Commission, New York.

"Uniform Legislation as Affecting Highway Traffic and Highway Transport," D. C. Fenner, manager, Public Works Department, International Motor Co., New York City.

"Construction and Maintenance of Earth Roads," George E. Johnson, secretary of Public Works, Lincoln, Neb.

"Highway Construction on the Pacific Coast," Herbert Nunn, State Highway Engineer, Salem, Ore.

"Co-operation of All Parties Interested in the Construction of a Modern Road," William Ord, manager, Paving Department, The Lakewood Engineering Co., Cleveland, O.

"The Business End of a State Highway Department," Charles M. Upham, State Highway Engineer, North Carolina State Highway Commission.

"The Highway Contractor's Problems," H. H. Wilson, Winston Brothers, Muncy, Pa.

State Highway Officials and Advertising Signs Along Highways.—At the recent annual meeting of the American Association of Highway Officials the following resolution was unanimously adopted:

Whereas, Advertising signs upon, along and adjacent to public highways serve no good purpose but, on the contrary, are a public nuisance in that they destroy the beauty of our landscapes, impair vision in dangerous places, and add to the difficulty of properly guiding and warning traffic; be it, therefore,

Resolved, that this Association pledges its support to any proper movement to eliminate such advertising signs and urges upon its individual members the importance of aiding and encouraging legislation in all states to effect said elimination, to the end that our highways may be fully and safely occupied and enjoyed by the public for the use of whom they are acquired and built.

State Highway Construction in 1921 and 1922

Reports from State Officials Showing Mileage and Expendituresr Last Year and Proposed Mileage and Funds Available for This Year

NEW ENGLAND STATES.

Maine.

The total expenditure in 1921 on state highway construction was about $3,000,000, of which [illegible] was for bituminous macadam, cement concrete and gravel roads. In addition state aid construction cost $1,300,000 and provided 175 miles of improved highway of which 80 per cent was gravel surface and 20 per cent miscellaneous type.

HIGHWAY CONSTRUCTION IN [illegible]

Type	Miles	Average width surface Ft.	Thickness Surface In.	Thickness Base In.	Average cost surface and base Per mile
Bituminous macadam	31.61	18	[illegible]	[illegible]	[illegible]
Cement concrete	17.01	18	[illegible]	[illegible]	[illegible]
Gravel	48.14	18	[illegible]	[illegible]	[illegible]

*Average. Includes foundations.

The amount available at present writing for state highway construction in 1922 is $1,638,000. The program includes the following:

	Miles
Bituminous macadam	[illegible]
[illegible]	[illegible]
Gravel	[illegible]

Paul O. Sargent, Augusta, Me., is chief engineer Maine State Highway Commission.

New Hampshire.

HIGHWAY CONSTRUCTION IN 1921

Type	Miles	Average width surface Ft.	Thickness Surface In.	Thickness Base In.	Av. cost surface and base Per mile
Gravel	[illegible]	21	[illegible]	[illegible]	[illegible]
Macadam	11.82	18	[illegible]	[illegible]	[illegible]
Mixed [illegible]	[illegible]	18	[illegible]	[illegible]	5,000

*[illegible]

Approximately $2,000,000 is available for highway construction and reconstruction in 1922.

Frederick E. Everett, Concord, N. H., is State Highway Commissioner.

Vermont.

HIGHWAY CONSTRUCTION IN [illegible]

Type	Miles	Average width surface Ft.	Thickness Surface In.	Thickness Base In.	Average cost surface and base Per mile
Gravel	[illegible]	18 to 21	[illegible]	[illegible]	[illegible]
Concrete	[illegible]	18	[illegible]	[illegible]	[illegible]
Waterbound macadam	[illegible]	21	[illegible]	[illegible]	[illegible] to 18,000
Bituminous macadam	[illegible]	18	[illegible]	[illegible]	[illegible] to 22,000

Plans for highway construction for 1922 are not yet completed. The program will be about the same as 1921.

Thurman W. Dix, Montpelier, Vt., is State Highway Commissioner.

Massachusetts.

The following is a brief outline of the work carried out in 1921 by the Division of Highways of the Department of Public Works of Massachusetts:

Water bound macadam	[illegible] per mile
Bituminous macadam	[illegible] per mile
Gravel	[illegible] per mile
Bituminous concrete	[illegible] per mile
Cement concrete	16.50 miles at about [illegible] per mile
Broken stone	[illegible] per mile
Sand and clay	[illegible] per mile

The following work is proposed for 1922:

	Miles
Cement concrete, about	[illegible]
Bituminous macadam asphalt, about	[illegible]
Bituminous macadam tar, about	16.2
Bituminous concrete asphalt, about	4.7
Gravel	[illegible]

A. W. Dean, Boston, Mass., is Chief Engineer of the Division of Highways.

Rhode Island.

HIGHWAY CONSTRUCTION IN [illegible]

Type	Miles	Average width surface Ft.	Thickness Surface In.	Thickness Base In.	Av. cost surface and base Per mile
Concrete	[illegible]	18	6-8	Variable	*$41,800
Bituminous concrete	29.3	18	8	Variable	[illegible]
Asphalt macadam	3.5	18	6-8	Variable	[illegible]
Macadam	1.6	16	6	Variable	[illegible]
Gravel	3.5	[illegible]	10	Variable	*11,700

*Total cost including engineering, [illegible] drainage and foundations.

The program for the 1922 work is not yet made up.

I. W. Patterson, Providence, R. I., is Chief Engineer State Board of Public Roads.

Connecticut.

HIGHWAY CONSTRUCTION IN 1921

Type	Miles	Average width surface Ft.	Thickness Surface In.	Thickness Base In.	Av. cost surface and base Per mile
[illegible]	[illegible]	18			[illegible]
Gravel	16.96	18	8	..	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]
Macadam	[illegible]	[illegible]	[illegible]		[illegible]
Bituminous macadam [illegible]	[illegible]	18	[illegible]	[illegible]	[illegible]
Bituminous concrete (asph.)	[illegible]	18	[illegible]	[illegible]	[illegible]
Concrete	[illegible]	18	[illegible]		[illegible]
Brick	[illegible]	18			..

About $3,000,000 is available for new highway construction in 1922 and contracts will be let for the following:

	Miles
Concrete	[illegible]
Bituminous macadam	[illegible]
Macadam	[illegible]
Gravel	[illegible]

The average unit contract prices on the 1921 work were as follows:

Earth excavation, per cu. yd.	$ [illegible]
Borrow, per cu. yd.	1.00
Rock excavation, per cu. yd.	3.50
Wet excavation, per cu. yd.	3.50
Cement rubble masonry, per cu. yd.	[illegible]
[illegible] corrugated metal pipe, per lin. ft.	2.00
[illegible] corrugated metal pipe, per lin. ft.	[illegible]
24-in. corrugated metal pipe, per lin. ft.	3.50
[illegible] corrugated metal pipe, per lin. ft.	4.50
[illegible] corrugated metal pipe, per lin. ft.	6.00
Wood guard rail, per lin. ft.	.50
[illegible] bituminous macadam surface, per sq. yd.	.90
7-in. broken stone base, per cu. yd.	3.50
[illegible] gravel surface, per sq. yd.	[illegible]
[illegible] waterbound macadam, per sq. yd.	1.20
Plain cement concrete pavement, per cu. yd.	11.00
Wire fence, per lin. ft.	.30
Cobble gutter, per sq. yd.	.80
Rubble drain, per lin. ft.	1.00

Charles J. Bennett, Hartford, Conn., is State Highway Commissioner.

MIDDLE ATLANTIC STATES.

New York.

During 1921 the State Commission of Highways held 14 lettings involving 160 contracts amounting to 615 miles of construction work divided into types as follows: 264 miles bituminous macadam, 332 miles concrete and 19 miles miscellaneous types. The estimated cost of the above construction, including engineering and contingencies, amounted to approximately $27,000,000. There was actually constructed during the year 618 miles of finished pavement divided into types as follows: 367 miles concrete, 168 miles bituminous macadam, 78 miles waterbound macadam and 5 miles miscellaneous. It is not possible at this time to state amount of funds available for 1922 construction but it will no doubt be equal to that of 1921.

Herbert S. Sisson, Albany, N. Y., is State Highway Commissioner.

New Jersey.

The following table shows the mileage of state, county township roads under construction, under contract ready for construction or completed during the year 1921:

	Miles
Sheet asphalt on concrete base	22.12
Sheet asphalt on stone base	[illegible]
Bituminous concrete on concrete base	53.24
Bituminous concrete on stone base	18.32
Concrete	[illegible]
Brick	.46
Block	[illegible]
Macadam, penetration	15.81
Macadam, waterbound	68.15
Macadam, surface treated	5.50
Gravel	[illegible]
Cinders	[illegible]
Slag	1.00
Other types	[illegible]

The average width of surfaced pavement built by the State Highway Department in 1921 is approximately 20 ft. Monolithic concrete pavements have been built 6 in. at the side and 8½ in. at the center, and 8 in. side and 10½ in. at the center, depending upon traffic conditions. Where bituminous top has been used, as an average condition, this has been 6 to 8½-in. concrete base, 2-in. top.

The average cost of surface and base has been approximately $60,000 per mile, including drainage.

The probable highway construction program in 1922 will be about 175 miles, including county, state aid work amounting to approximately $10,250,000. The type of pavement to be used will probably be monolithic concrete, and concrete base with bituminous surface.

T. J. Wasser, Trenton, N. J., is State Highway Engineer.

Pennsylvania

During 1921 the state constructed 670 miles of durable highways into which concrete entered in some form, and resurfaced 544 miles of macadam. Total expenditure for construction in 1921 was $35,000,000. Amount expended for road maintenance was $9,700,000. It is not possible at this time to give figures on the work for 1922.

W. D. Uhler, Harrisburg, Pa., is Chief Engineer State Highway Department.

Delaware.

HIGHWAY CONSTRUCTION IN 1921

Type	Miles	Average width surface. Ft.	—Thickness— Surface. In.	Base. In.	Ave. cost surface and base. Per mile
Concrete	57.2	16	6	8	$32,656
Pen. macadam	7	14	3	8	20,120

At present $2,250,000 is available for the 1922 construction. The program includes 60 miles of concrete pavement.

The average unit prices in 1921 were as follows:

Concrete 1:2:4, per cu. yd.	$16.58
Excavation, per cu. yd.	1.21
Concrete pipe, 15 in.	3.00
Masonry 1:2:4	27.05

C. D. Buck, Dover, Del., is Chief Engineer State Highway Department.

Maryland.

The following table summarizes the construction activities of the Maryland State Roads Commission in 1921:

Type of surfacing	Constr. previous to 1-1-21.	Carried over from 1921	Awarded during 1921.	Constr. during 1921.	Carried over to 1922.	Total constr. to 12-31-21.	Total cost of 1921 awards.	Ave. cost per mile of 1921 awards.
Macadam	940.26	1.45	15.29	15.35	1.39	955.61	$ 253,373	$16,571
Concrete	395.89	17.94	97.84	103.71	12.07	499.60	3,231,002	33,023
Bituminous concrete	28.19	0.90	0.00	0.00	0.00	28.19	....	......
Shell	73.55	0.00	0.00	0.00	0.00	73.55	....	......
Gravel	181.97	18.18	25.02	33.60	9.60	215.57	232,056	9.274
Brick	7.09	0.00	0.00	0.00	0.00	7.03	....	......
Asphalt	39.14	3.07	7.35	5.42	5.00	44.56	293,693	39.958
	1,666.09	40.64	145.50	158.08	28.06	1,821.17	$4,010,126	......
Asphalt resur. roads previously constructed	0.00	0.00	1.86	1.86	0.00	1.86	51,152	27,501
Con. shoulders adj. to roads previously constructed	70.89	0.90	14.56	13.99	0.57	84.88	174,384	11.977
Grading only	0.00	0.00	1.03	0.74	0.29	0.74	32,772	31,817
	1,736.98	40.64	162.95	174.67	28.92	1,911.65	$4,268,434	......

John N. Mackall, Baltimore, Md., is Chairman and Chief Engineer of the State Roads Commission.

SOUTH ATLANTIC STATES.

Virginia.

HIGHWAY CONSTRUCTION IN 1921.

Type.	Miles	Average width surface. Ft.	—Thickness— Surface. In.	Base. In.	Ave. cost surface and base. Per mile
Bituminous macadam	57.0	16	[illegible]	6	$28.370
Surface treated macadam	86.5	15			15,600
Concrete	[illegible]	16	7	7	33,000
Gravel	49	16	8	8	7,500
Soil	198	20	10	10	7,500
All others	82	16			

The appropriations for the 1922 work has not yet been made. The probable construction program, however, includes:

	Miles.
Concrete	100
Bituminous macadam	100
Asphalt	50
Gravel and soil	150

G. P. Coleman, Richmond, Va., is State Highway Commissioner.

West Virginia.

WORK CONSTRUCTED DURING 1921

Type.	Miles.	Average width. Ft.	Surface thickness In.	Average cost Per mile.
Graded earth	15	[illegible]		12,500
W. B. macadam	[illegible]	10-16	[illegible]	[illegible]
Gravel	[illegible]	9-16	12	6,000
Bituminous macadam	[illegible]	10-16	[illegible]	12,000
Concrete	[illegible]	[illegible]	[illegible]	[illegible]
Brick	[illegible]	12-16	6-4 [illegible]	36,000
Asphalt concrete	3	[illegible]	[illegible]	[illegible]

PROBABLE CONSTRUCTION IN 1922

Type.	Miles.	Amount available.
Graded earth	17	[illegible]
Hard surface	[illegible]	[illegible]
		[illegible]

APPROXIMATE UNIT BIDDING PRICES.

Excavation	$ 1.10
Surface	3.25
Concrete, Class A.	26.00
Concrete, Class B.	21.00
Concrete, Class C.	20.00
Reinforcement	10
V. C. pipe, 12-in.	2.35
V. C. pipe, 15-in.	2.80
V. C. pipe, 18-in.	3.50
V. C. pipe, 24-in.	5.25
Wooden railing	1.00

C. P. Fortney, Charleston, W. Va., is Chairman State Road Commission of West Virginia.

North Carolina.

At present North Carolina has under construction or contracted for 591 miles of road of the topsoil, sand-clay or gravel type, costing approximately $5,100,000; approximately 300 miles of the various hard surface types costing $8,750,000; bridge work costing approximately $400,000.

During the past year there has been completed approximately 380 miles of the topsoil, sand-clay, or gravel type at an approximate cost of $4,000,000; 85 miles of hard surfaced roads costing in round figures $3,000,000, and bridge work costing approximately $250,000.

These figures include both State and Federal Aid work but do not include work that is being done by counties.

During the coming year the State Highway Commission expects to let contract and put under construction 400 miles of paving and 600 miles of the various lower type roads.

Charles M. Upham, Raleigh, N. C., is Chief Engineer North Carolina State Highway Commission.

South Carolina.

HIGHWAY CONSTRUCTION IN 1921.

Type	Miles	Average width surface Ft.	—Thickness— Surface. In.	Base. In.	Ave. cost surface and base. Per mile.
Concrete	27	16	7		$32,000
Asphaltic, mixed	2	18	2	[illegible]	33,000
Gravel	4	20	10		6,000
Other types	717	20	10		4,000

PROBABLE HIGHWAY CONSTRUCTION IN 1922.

Type.	Miles.	Amount available.
Hard surface	70	$2,240,000
Other types	680	2,720,000
Total	750	$4,960,000

AVERAGE UNIT CONTRACT PRICES IN 1921.

Clearing and grubbing	$131.90
Common excavation	0.314
Dry excavation	0.356
Wet excavation	3.90
Top-soil surfacing	0.388
Sand-clay surfacing	0.308
Gravel surfacing	0.37
Bituminous concrete surfacing	2.70
Plain concrete surfacing	2.75
Concrete, Class "A"	25.64
Concrete, Class "B"	20.70

Chas. Moorefield, Columbia, S. C., is State Highway Engineer.

Georgia.

During 1921 about 1,000 miles of highway were constructed at an expenditure of $10,000,000. Present plans call for the construction of 500 miles in 1922 at an expenditure of about $8,000,000. W. R. Neel, Atlanta, Ga., is State Highway Engineer.

Florida.

HIGHWAY CONSTRUCTION IN 1921.

Type.	Miles.	Width. Ft.	Thickness. In.	Cost per mile.
Concrete	10	16	6	$30,600
Brick	21	16	Sand base.	30,000
Penetration	24	16	*	25,000
Sheet asphalt	5	16	*	30,000
Surface treatment	150	16	8-in. base	15,000
Sand-clay	36	20	8-in. base	8,000

*Base 8-in., 3-in. wearing surface

PROBABLE CONSTRUCTION IN 1922.

Type.	Miles.	Width.	Thickness.
Concrete	37	16	6-in.
Brick	20	16	Sand base

Penetration	150	16	Base 8 [illegible] wear. surface
Sheet asphalt	10	16	Base 8 [illegible] wear. surface
Gravel	10	18	8 in.
Surface treatment	100	16	8 in. base
Sand-clay	50	20	8 in.

Chas. A. Browne, Tallahassee, Fla., is State Highway Engineer.

EAST SOUTH CENTRAL STATES.

Kentucky.

HIGHWAY CONSTRUCTION IN 1921.

Type	Miles	Av. width surface Ft.	Thickness Surface In.	Thickness Base In.	Av. cost surface and base Per mile
Grade and drain	176.3	24			$15,000
Gravel	40.6	1[illegible]		[illegible]	[illegible],000
Waterbound macadam	128.[illegible]	14	[illegible]	4	[illegible]5,000
Surface treatment	23.[illegible]	14	[illegible]		1,000
Penetration macadam	11.4	16	[illegible]	[illegible]	30,000
Rock asphalt	22.4	18	[illegible]	[illegible]	38,000
Brick	[illegible]	14	3	[illegible]	42,000
Cement concrete	6.6	18	[illegible]	[illegible]	[illegible],000

*Estimated.

It is not possible at this time to give you any accurate information on the roads to be constructed during 1922 for the reason that the Department's program will depend altogether upon the funds provided by the next legislature which convenes Jan. 1, 1922.

Joe S. Boggs, Frankfort, Ky., is State Highway Engineer.

Tennessee.

HIGHWAYS UNDER CONSTRUCTION IN 1921.

Type	Miles	Av. width surface Ft.	Thickness Surface In.	Thickness Base In.	Av. cost surface and base Per mile
One course concrete	26.52	20	6	8	$33,000
Rock asphalt	44.50	18	1½	8	23,500
Bituminous concrete	15.93	20	2	8	22,800
Bit. penetration macadam	209.62	18	2½	8	14,[illegible]00
Waterbound macadam	68.95	16	2½	8	9,000
Chert	87.65	16	[illegible]	4	6,000

Approximately $3,500,000 is now available for highway construction in 1922.

The average unit contract prices for the more common items of the 1921 construction are approximately as follows:

Common excavation	$0.60 per cu. yd.
Borrow excavation	.60 per cu. yd.
Rock excavation	1.50 per cu. yd.
Modified Telford base course	1.00 per sq. yd.
2½-in. penetration bituminous macadam surface	.75 per sq. yd.
Concrete 1:2:4 mix	22.00 per cu. yd.

D. Q. McComb, Nashville, Tenn., is Chief Engineer of the State Highway Department.

Alabama.

During 1921 the State Highway Department completed 89.2 miles of road at a total cost of $1,000,472. In addition $189,951 was expended for bridges. The type of roads and their cost were as follows:

SAND-CLAY ROADS COMPLETED DURING 1921.

Proj. No.	Miles	Cost per mile
48	5	$ 1,716
[illegible]	[illegible]	7,157
101	[illegible]	[illegible],579
[illegible]	[illegible]	9,1[illegible]8
[illegible]	4	5,366
65	[illegible]	6,850

GRAVEL ROADS COMPLETED DURING 1921.

Proj. No.	Miles	Cost per mile
80	12.[illegible]	$
60	2.[illegible]	2,806
[illegible]	2.[illegible]	1[illegible],677
[illegible]	2.[illegible]	3,401
[illegible]	[illegible]	8,220
4[illegible]	[illegible]	7,500
[illegible]	4.[illegible]	12,[illegible]67
[illegible]	[illegible]	4,45[illegible]
[illegible]	[illegible]	12,572
[illegible]	[illegible]	11,268
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	17,[illegible]45
[illegible]	1.[illegible]	11,[illegible]40

BITUMINOUS MACADAM COMPLETED DURING 1921.

Proj. No.	Miles	Cost per mile
[illegible]	[illegible]	$[illegible]7

MACADAM ROADS COMPLETED DURING 1921.

Proj. No.	Miles.	Cost per mile.
[illegible]	[illegible]	$
[illegible]	2.0	7,798
[illegible]	[illegible]	[illegible]

WARRENITE BITULITHIC COMPLETED DURING 1921.

Proj. No.	Miles	Cost per mile
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

CONCRETE ROAD COMPLETED DURING 1921.

Proj. No.	Miles	Amount
[illegible]	[illegible]	$[illegible]

The above figures do not include the work done by the counties and which the State Highway Department did not supervise. The probable highway construction for 1922 includes the following:

Type	Miles	Amount available
Asphalt or concrete	1[illegible]	$1,600,000
Bituminous macadam	[illegible]	1,300,000
Gravel	180	2,400,000
Sand-clay	6[illegible]	150,000

The average unit bidding prices on the more common items of the 1921 work were as follows:

Common excavation	$ [illegible] per cu. yd.
Solid rock excavation	1.00 per cu. yd.
Clearing and grubbing	125.00 per acre
Class A concrete	22.00 per cu. yd.
Class B concrete	20.00 per cu. yd.
18-in. [illegible] S. V. C. pipe in place	1.60 per lin. ft.
[illegible]-in. [illegible] S. V. C. pipe in place	2.50 per lin. ft.

W. S. Keller, Montgomery, Ala., is State Highway Engineer.

Mississippi.

The following summarizes the activities of the State Highway Department in 1921:

Total mileage of roads constructed will approximate 332 miles of which 100 miles consists of grading and bridging only, preparatory to surfacing at a later date; 200 miles of grading, bridging and gravel surfacing ranging in width from 10 ft. to 24 ft.; 5 miles of waterbound slag macadam; 15 miles 1 course concrete ranging in width from 9 ft. to 18 ft., with a thickness of 6 in. at the edges and 8 in. at center; 6 miles of Kentucky rock asphalt on a 5 in. concrete base; and 6 miles of vitrified brick surfacing with bituminous filler.

For the year 1922 the mileage of gravel road construction will not be as large as for 1921, as a larger percentage of the Department's work will be of a permanent hard surfaced type.

H. C. Dietzer, Jackson, Miss., is State Highway Engineer.

EAST NORTH CENTRAL STATES.

Ohio.

Up to Nov. 15 the State Division of Highways had paid final estimates on 512 miles of road, about 131 miles of which were brick, 118 miles of concrete, 15 miles of gravel, about 33 miles of the higher types of bituminous pavements, and about 215 miles of macadam. The average width of the surface is probably 16 ft. and the average thickness probably 9 or 10 in.

The Division will probably construct 400 or 500 miles of road in 1922, the type of which is indeterminate at the present time.

E. C. Blosser, Columbus, O., is State Highway Engineer.

Indiana.

During 1921 the State Highway Commission constructed 78.64 miles of concrete road of an average width of 18 ft., and an average thickness of 6 in. — 8 in., and 3.86 miles of bituminous concrete. The latter had an average width of 18 ft., a 2½-in. surface and a 6-in. base.

The program for next year is rather indefinite at this time and depends to a very large extent on the lowness of the bids submitted at our first letting which will probably be held during the middle of January.

C. Gray, Indianapolis, Ind., is Chief Engineer State Highway Commission.

Illinois.

The Division of Highways of the State Department of Public Works and Buildings built 400 miles of concrete pavement during 1921. The width of surface will average 18 ft. The thickness of the pavement is 7 and 8 in. The cost per mile for grading, paving, bridges and culverts will average $28,662.

If conditions are favorable the Division contemplates placing 1,000 miles of pavement under contract next year; in addition to completing the mileage carried over from this season.

The Department of Public Works and Buildings on Oct. 25, 1921, sold $5,000,000 of the $60,000,000 bond issue. This, together with the Federal appropriation to Illinois, and other road funds available, will give approximately $35,000,000 for construction and maintenance purposes in 1922.

The average unit prices for pavement received at the letting on Nov. 4, 1921, were as follows:

Excavation	$.[illegible]7 per cu. yd.
Subgrade	[illegible] per sq. yd.
Concrete pavement	1.[illegible]1 per sq. yd.*
Concrete in bridges and culverts, Class A	1[illegible] per cu. yd.
Reinforcing steel	.05 per lb.

*Does not include cement.

Clifford Older, Springfield, Ill., is Chief Highway Engineer of the Division of Highways.

Michigan.

The following information covers only contracts awarded by the State Highway Department and does not include the mileage on nontrunk line roads where the contracts were awarded by the counties or townships:

HIGHWAY CONSTRUCTION TO DEC. 1, 1921.

Type.	Miles.	Average width surface. Ft.	Thickness Surface. In.	Thickness Base. In.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	16	3	5
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	16	[illegible]	[illegible]
Bituminous surface treatment	[illegible]			[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	18	[illegible]	6
[illegible]	[illegible]	[illegible]	1	[illegible]
Total	[illegible]			

[illegible]-1-in. cushion.

PROBABLE HIGHWAY CONSTRUCTION IN 1922.

Type.	Miles.
Grading and drainage structures	[illegible]
[illegible] gravel	1.5
[illegible] gravel	[illegible]
Stone base, gravel top	[illegible]
Waterbound macadam	44
Bituminous macadam	16
Concrete or bituminous concrete	[illegible]
Total	[illegible]

For 1922, $13,000,000 is available for roads and $2,000,000 for bridges of 30-ft. span or over.

Frank F. Rogers, Lansing, Mich., is State Highway Commissioner.

Wisconsin.

A preliminary compilation of the 1921 work of the Wisconsin Highway Commission follows:

Type.	Federal Aid Miles.	Federal Aid Cost.	State Aid Miles.	State Aid Cost.	Gang Maintenance Miles.	Gang Maintenance Cost.	Totals Miles.	Totals Cost.	Cost per mile.
Graded and Surfaced—									
Concrete	100.0	$3,400,000	240.0	$7,450,000	....	....	340.0	$10,850,000	$32,000*
Bituminous macadam	8.7	250,000	21.0	295,000	......	....	29.7	545,000	18,350*
Plain macadam		...	33.0	190,000	......	....	33.0	190,000	5,750*
Gravel	205.0	1,700,000	538.0	1,800,000	230.0	$ 520,000	973.0	4,020,000	4,130*
Miscellaneous	65.0	527,000	111.0	215,000	53.0	62,000	229.0	804,000	3,500*
**Graded and surfaced	378.7	$5,877,000	943.0	$9,950,000	283.0	$ 582,000	1,604.7	$16,409,000	....
Graded Only—									
Graded and drained	176.0	1,200,000	677.0	1,450,000	525.0	190,000	1,378.0	2,840,000	2,060*
Total new grading	554.7	....	1,620.0	....	808.0	....	2,982.7	....	.....
Surfaced Only—									
*Gravel	.....	......	334.0	534,000	170.0	185,000	504.0	719,000	1,125*
* [illegible]	..	....	67.0	180,000	52.0	72,000	119.0	252,000	2,120*
Totals	554.7	$7,077,000	2,021.0	$12,114,000	1,030.0	$1,029,000	3,605.7	$20,220,000	....

*Grand total gravel, 1,477 miles. **Grand total all surfaces, 2,228 miles.

Practically all the concrete surfaces are 18 ft. wide, 8 in. thick at the center and 7 in. thick at the sides.

The program for 1922 construction will be as large as that of 1921, if not larger, especially in concrete roads. The present plans call for about 400 miles of this type.

A. R. Hirst, Madison, Wis., is State Highway Engineer.

WEST NORTH CENTRAL STATES.

Minnesota.

The work in 1921 included 89 miles of concrete road, 26 miles of asphaltic type, 1,000 miles of gravel and 1,200 miles of grading. The expenditure for construction was $9,300,000. In addition $4,500,000 was expended for maintenance. The program for 1922 will be approximately the same as for last year. John H. Mullen, St. Paul, Minn., is Chief Engineer State Highway Commission.

Iowa.

HIGHWAY CONSTRUCTION IN 1921.

Type.	Miles	Av. width surface Ft.	Surface. In.	Base. In.	Av. cost surface-base per mile.
[illegible]	[illegible]	18	3*	5 and 6	$58,100**
[illegible]	151.92	18 and 20	Cen. 8	Edge 7-8	40,700
[illegible]	[illegible]	18	Cen. 8	Edge 8	[illegible]
[illegible]	[illegible]	20	Cen. 5	Edge 1½	2,500†
[illegible]	1,050.88	28	......	......	3,300†

**Both base and top let at one price. *Also 1-in. cushion. †Approximate only.

PROBABLE HIGHWAY CONSTRUCTION IN 1922.

Type.	Miles.	Av. cost per mile.
Concrete, [illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
Gravel roads	[illegible]	[illegible]

Fred R. White, Ames, Ia., is Chief Engineer State Highway Commission.

Missouri.

HIGHWAY CONSTRUCTION IN 1921.

Type.	Miles 1921.	Average width surface. Ft.	Av. cost surface and base. Per mile.
Earth	[illegible]	[illegible]	[illegible]
Gravel and macadam	143	16 to 18	11,976.32
Bituminous macadam	17	16 to 18	21,908.10
Concrete	47	16 to 20	35,151.53
Brick	2	18 to 20	47,192.67
Total	602		Av. $[illegible],590.17

For 1922, $15,000,000 is available, Alexander W. Graham, Jefferson City, Mo., is State Highway Engineer.

Kansas.

This state constituted 285 miles of road in 1921 at a cost of $7,100,000. It is possible the 1922 work will include 420 miles of road construction at an estimated cost of $9,500,000. M. W. Watson, Topeka, Kan., is State Highway Engineer.

North Dakota.

HIGHWAY CONSTRUCTION IN 1921

Type	Miles.	Average width surface. Ft.	Surface In.	Av. cost surface and base. Per mile.
(a) Earth	383	24	.....	$4,000
(b) Gravel surfacing	102	18	6 center	2,700
(c) Concrete	2	16	7 center	60,000

Completed.

(d) Earth—equivalent to (a) above.
(e) Gravel surfacing—about one-half of (b) above.
(f) Concrete—(c) above.

The tabulation below is of mileage figures taken from the records of the Project and Maintenance Engineer.

	Completed. Miles.	Under construction Miles.	Proposed for construction in 1922 Miles.	1923. Miles.	1924. Miles.	Total. Miles.
Grading	565.1	634.6	604.9	514.8	403.5	2,722.9
Surfacing	55.5	71.2	299.9	269.1	317.1	1,013.0
Approximate cost in units of million dollars	2½	4½	3¾	3	2¾	16½

The miles reported as "completed" are the total of miles of projects transferred to maintenance. The projects comprising the 634.6 miles reported as "Under Construction" averages about 80 per cent complete.

The cost of the projects "Completed," "Under Construction" and "Proposed Construction in 1922" are as financed by state and county funds, approximately 50 per cent, and Federal Aid, of the 1916, 1919 and 1921 appropriation approximately 50 per cent. (Under construction includes the Missouri River Bridge, F. A. P. 100, between Mandan and Bismarck, costing approximately $1,324,000.) In general, the state has a state highway fund of less than $500,000 a year and the counties apply from their own levies the money needed to meet Federal Aid.

The miles reported as "Proposed for Construction in 1923" and "in 1924" are in tentative plan for Federal Aid expected to be made available, by later Congressional appropriation, for those years, counties of the state having made application for improvement, projects and having offered to provide for half of the cost. North Dakota's allotment of Federal Aid is on the basis of about 1½ per cent so that if Federal Aid be made available to all of the states for the years 1923 and 1924 at the rate of $100,000,000 a year more mileage than at present proposed can be financed on a 50 per cent Federal Aid basis while if the Federal Aid should continue to be available, to all of the states, at the rate of only $75,000,000 per year, some of the projects proposed for 1923 and 1924 would need to be postponed to 1925 in order to receive 50 per cent Federal Aid.

W. H Robinson, Bismarck, N Dak., is Chief Engineer and Secretary of the State Highway Commission.

South Dakota.

The State Highway Department has built only earth and gravel roads. 21.17 miles of gravel and 11.83 miles were finished before 1921 under Federal Aid, and 274.8 miles of gravel and 320 miles of earth roads were carried over to last year. This work also was under Federal Aid. A total of 139.75 miles of gravel and 274.76 miles of earth Federal Aid roads were let in 1921. In addition 11.67 miles of State Aid earth roads were under way last year.

About $2,500,000 probably will be spent in 1922 for road construction.

F. W. Schreiber, Pierre, S. Dak., is State Highway Engineer.

Nebraska.

HIGHWAY CONSTRUCTION IN 1921

Type.	Miles.	Average width surface Ft.	[illegible]	Av. cost surface and base per mile.
Earth	[illegible]	24		[illegible]
Gravel	[illegible]	18	[illegible]	[illegible]
Concrete	[illegible]	18	[illegible]	[illegible]

About $4,000,000 is available for highway construction in 1922.

The average unit contract prices in 1921 for the more common items of highway construction were:

Earth construction	$ .33 per [illegible]
Gravel construction	.54 per [illegible]
Concrete construction	3.19 per [illegible]
Concrete culvert headwalls	35.24 per cu. yd.
Concrete box culverts	32.56 per cu. yd.

George E. Johnson, Lincoln, Neb., is Secretary, State Department of Public Works.

WEST SOUTH CENTRAL STATES.

Arkansas.

Road construction in 1921 included the following: Graded, 386 miles; gravel roads, 1,350 miles; macadam, 160 miles; surface treated gravel, 13 miles; surface treated macadam, 22 miles; asphaltic macadam, 44 miles; asphaltic concrete, 208 miles; cement concrete, 63 miles. The total expenditure was $22,000,000. Present plans call for the construction in 1922 of about 1,500 miles and the expenditure of $12,000,000.

R. C. Limerick, Little Rock, Ark., is State Highway Engineer.

Oklahoma.

During 1921 162 miles of highway were constructed by the state under Federal Aid and 32 miles were built by counties. The total estimated cost is $4,847,000. The present program for 1922 calls for the construction of 252 miles by the state under Federal Aid at an estimated cost of $4,652,000. In addition 169 miles are contemplated at an estimated cost of $3,141,000. Approximately $4,000,000 is available from county bond issues, and about $5,100,000 additional is available from state and county funds. Bond issues have been voted by counties for the construction of 450 miles of road.

Ernest S. Alderman, Oklahoma City, Okla., is State Engineer.

New Mexico.

Approximately 720 miles of highway were built in 1921 at a total expenditure of $2,740,000. The 1922 program calls for about 900 miles and an expenditure of $3,500,000.

MOUNTAIN STATES.

Montana.

The tabulation below summarizes the Federal Aid program of this state to Dec. 1, 1921:

Status	Length Graded	Length Gravel	Length Paved	Length Total	Cost (Est'd 10% com.)
Completed projects	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Uncompleted projects under construction contract	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Projects contracted in 1919	[illegible]	[illegible]		[illegible]	[illegible]
Projects contracted in 1920	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Projects contracted in 1921	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total all contracted projects	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Projects advertised for letting					None
Project statements approved by the Secretary of Agriculture	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Project statements submitted to the Bureau of Public Roads	[illegible]	[illegible]		[illegible]	[illegible]
Project statements withdrawn or rejected	[illegible]	[illegible]	[illegible]	[illegible]	1,305,415
Value of construction work accomplished prior to Dec. 1, 1920					3,174,912
Value of construction work accomplished since Dec. 1, 1920					[illegible]
[illegible]					[illegible]
[illegible]					[illegible]
Total Federal Aid [illegible]					[illegible]
Federal Aid to be matched [illegible]					[illegible]
[illegible]					[illegible]
[illegible]					[illegible]

The average prices prevailing for work contracted during the past season as follow:

Graded roads, $[illegible] per mile.
Gravel roads, $[illegible] per mile.
Paved roads, $[illegible] per mile.
Common excavation, $[illegible] per cu. yd.
[illegible] excavation, $[illegible] per cu. yd.
Rock excavation, $[illegible] per cu. yd.
Class A concrete, $[illegible] per cu. yd.
Class B concrete, $22.57 per cu. yd.
Gravel surfacing, $[illegible] per cu. yd.

The costs per mile as given above are exclusive of engineering supervision charges and bridges of over 20 ft. span.

Nearly all graded roads contracted consist of heavy mountain construction and the costs are thus proportionately high.

The 6.5 miles of paved roads shown in the summary consist of a 2½ in. bituminous macadam surfacing 18 ft. wide on a 4 in. crushed rock base.

Prices shown for rock excavation and Class A concrete are exclusive of those bridge contracts where costs of concrete are exceptionally high due to the fact that excavation charges must be absorbed in price bid for concrete and the concrete was placed beneath the water surface.

John N. Edy, Helena, Mont., is Chief Engineer, State Highway Commission.

Idaho.

HIGHWAY CONSTRUCTION IN 1921

Type.	Miles.	Av. width surface	Thickness Surface. In.	Thickness Base. In.	Av. cost surface and base per mile
Earth	[illegible]	18	...	0	$41,364*
Crushed rock	[illegible]	18	...	7	13,356
Gravel	[illegible]	18	...	[illegible]	12,518
Concrete	7.0	18	...	7	41,407
Concrete with bituminous concrete surface	11.6	18	1½	5	54,284†
Bituminous concrete	11.6	18	2	4	41,753
Reinforced concrete	1.5	18	[illegible]	0	27,225‡

*Very precipitous mountain road in Salmon River Canyon costing in places over $67,000 per mile. †Includes one 140-ft. steel span and one 240-ft. steel span. ‡Includes large number concrete siphons under road. ∥Topping only on old concrete base.

PROBABLE HIGHWAY CONSTRUCTION IN 1922

Type.	Miles.	Amount available.
Earth	30	$590,000
Paving	16	[illegible]
Gravel or crushed rock	66	912,000

It should be noted that the highway construction program for 1922 is only figured on a basis of what it is felt can be assured at the present time and does not by any means take into account the entire program which it is hoped to build during this coming year. The exact mileage has been left in abeyance at the present time owing to the fact that the state is now taking up several matters in regard to the new Federal Aid act which will make a considerable difference to Idaho on mileage constructed.

D. P. Olson, Boise, Idaho, is Director, Bureau of Highways of State Department of Public Works.

Colorado.

HIGHWAY CONSTRUCTION IN 1921

Type.	Miles.	Av. width surface Ft.	Thickness surface. In.	Av. cost per mile
Concrete pavement	24	18	6-7½	[illegible]
Gravel	[illegible]	16	6	[illegible]
Sand clay	4	16	6	[illegible]
Graded	[illegible]	[illegible]	0	[illegible]

PROBABLE HIGHWAY CONSTRUCTION IN 1922

Type.	Miles.	Amount available
Concrete pavement	40	[illegible]
Gravel surfacing	40	[illegible]
Sand clay		
Graded	[illegible]	[illegible]

The 1922 budget is not yet adopted, as information concerning probable construction during 1922 is incomplete.

The average unit prices for work let by the State Highway Department during the first 6 months of 1921 were as follows:

Clearing and grubbing, per acre	[illegible]
Excavation, common, per cu. yd.	[illegible]
Excavation, rock, per cu. yd.	[illegible]
Borrow fill, per cu. yd.	[illegible]
Sand cushion, per cu. yd.	[illegible]
Gravel shoulders, per cu. yd.	2.895
Sand clay surface, per cu. yd.	[illegible]
Gravel, per cu. yd.	2.5772
[illegible], per cu. yd.	[illegible]
Cement concrete pavement, per cu. yd.	[illegible]
State cement furnished, per cu. yd.	[illegible]
Bituminous surface, per [illegible]	[illegible]
Class "A" concrete, per cu. yd.	28.36
State cement furnished, per cu. yd.	[illegible]
Class "B" concrete, per cu. yd.	[illegible]

State cement furnished, per cu. yd.	26.62
Reinforcement, per lb.	0.1027
Cement rubble masonry, per cu. yd.	11.776
Dry rubble masonry, per cu. yd.	5.272
Concrete culverts, 18 in., per lin. ft.	3.446
Concrete culverts, [illegible] in., per lin. ft.	5.438
Vitrified tile under drain, 6 in., per lin. ft.	0.93
Vitrified sewer pipe, 12 in., per lin. ft.	1.50
Corrugated metal pipe, 12 in., per lin. ft.	2.257
Corrugated metal pipe, 15 in., per lin. ft.	2.547
Corrugated metal pipe, 18 in., per lin. ft.	2.92
Corrugated metal pipe, 21 in., per lin. ft.	3.395
Corrugated metal pipe, 24 in., per lin. ft.	3.759
Corrugated metal pipe, 30 in., per lin. ft.	4.71
Corrugated metal pipe, 36 in., per lin. ft.	5.802
Corrugated metal pipe, 48 in., per lin. ft.	[illegible].802
Pipe railings, per lin. ft.	2.20
Timber piling, per lin. ft.	1.449
Structural steel, per lb.	0.1073
Timber, per M. ft. B. M.	59.997
Corrugated metal siphons, 15 in., per lin. ft.	3.074
Corrugated metal siphons, 18 in., per lin. ft.	3.46
Corrugated metal siphons, 24 in., per lin. ft.	4.426
Rock fill, per cu. yd.	2.656
Rip rap, per sq. yd.	1.94
Stone paving, per sq. yd.	2.275
Cast iron, per lb.	0.1567

L. D. Blauvelt, Denver, Colo., is State Highway Engineer.

Arizona.

HIGHWAY CONSTRUCTION IN 1921

Type	Miles	Average width surface Ft	Thickness Surface In	Thickness Base In	Ave. cost surface and base Per mile
Concrete pvt.	37	16 and 18		6	$30,000
Asphalt con.	3	18	2	4	25,000
Gravel	250	18	6		*5,000

*To $75,000 in heavy mountain work.

About $3,000,000, including State, Federal Aid and County funds, is available for highway construction in 1922. The probable program includes 300 miles of gravel road, and 12 miles of pavement.

Thomas Maddock, Phoenix, Ariz., is State Highway Engineer.

Utah.

In 1921 132.6 miles of highway were constructed at a cost of $1,393,415. The approximate probable mileage for 1922 is 101.8, of which 75 per cent will be of the hard surface type. About $2,100,000 is available for this year.

Nevada.

HIGHWAY CONSTRUCTION IN 1921

Type.	Miles.	Av. width roadway Ft.	Surface Width. Ft.	Surface Thickness In.	Average cost surface Per mile.	Average cost project. Per mile.
Concrete	14.3	21	15	6	$35,000	$42,000
Gravel	22.1	21	15	5	5,000	12,000

PROBABLE HIGHWAY CONSTRUCTION IN 1922

Concrete, miles	22.8
Gravel or crushed rock, miles	179.0
Surfacing with gravel of projects now graded, miles	29.0
Probable amount available	$2,500,000

The 1921 construction program was very small on account of lack of funds. The new Federal Highway Law makes possible a much larger program for 1922.

G. W. Borden, Carson City, Nev., is acting State Highway Engineer.

Wyoming.

During 1921 the State Highway Department expended $2,200,000 for construction and $300,000 for maintenance. The mileage constructed was as follows:

Type	Miles	Average width surface Ft	Surface In
Concrete	1.2	16	..
Gravel	150.0	16	[illegible]
Grading, etc.	[illegible]	[illegible]	

The program for 1922 has not yet been determined. However, $2,200,000 is available for construction and $200,000 for maintenance

PACIFIC COAST STATES.

California.

WORK CONTRACTED IN 1921 BY CALIFORNIA HIGHWAY COMMISSION.

Type	Length Miles	Standard width Ft.	Average thickness In.	[illegible]
Concrete base	[illegible]	[illegible]	[illegible]	[illegible]
Bituminized [illegible]	[illegible]	16	[illegible]	[illegible]
Asphalt concrete	[illegible]	[illegible]		[illegible]
Earth grading	[illegible]	[illegible]		[illegible]
SURFACING AND WIDENING.				
Asphalt concrete surface (2 [illegible])	[illegible]	[illegible]		[illegible]
Concrete [illegible] 2½ [illegible]	[illegible]			[illegible]
Second story concrete base	[illegible]	[illegible]	[illegible]	[illegible]
Widening 8 ft. conc. pavement to 16 ft.	11.72	8	6	13,200
Gravel surface upon earth road	41.40	18	4	2,860

*Most of these contracts also include the grading. †Mostly mountain sections. ‡4 in. 2nd story on old base, 8 in. shoulders. §Including shoulders.

In addition to the above operations, the commission has authorized during the year the construction of 26 bridges of different types, the majority being reinforced concrete type, with lengths varying from 1,178 ft. to 60 ft. span.

PROBABLE WORK TO BE CONTRACTED DURING 1922.

Type	Length Miles	Estimated cost.
Grading and paving	277.59	
Grading and surfacing	301.35	$13,000,000

Work under way on Jan. 1, 1922, will probably bring total expenditures during the year in excess of $15,000,000.

AVERAGE UNIT CONTRACT PRICES.

Type	Labor. Per cu. yd.	Material. Per cu. yd	Total. Per. cu. yd.
5 in. x 15 ft. reinforced concrete base	8.05	10.29	18.34
Reinforced concrete culverts	22.62	11.30	33.92
Excavation without classification	1.00	.....	1.00

Austin B. Fletcher, Sacramento, Calif., is State Highway Engineer.

Oregon.

HIGHWAY CONSTRUCTION IN 1921.

Type.	Miles	Average width surface	Thickness Surface. In.	Thickness Base. In	Ave. cost surface and base. Per mile.
7 in. cement concrete	51	16	..	..	$30,000
5 in. bituminous concrete	125	16	3	2	30,000
Metal surfacing	444	16	6 total		6,000
Grading	450	24	.	..	15,000

It is not possible at present to give the mileage of probable construction during 1922. However, there remains to be expended under existing contracts the sum of approximately $6,000,000. It is probable that the same amount in new contracts will be awarded for 1922 construction.

The average contract price on the more important items of construction have been as follows:

Common excavation, per cu. yd.	.30
Intermediate excavation, per cu. yd	.60
Solid rock excavation, per cu. yd.	1.00
Overhaul, per sta. yd.	.05
12-in. culvert pipe, per lin. ft.	1.90
18-in. culvert pipe, per lin. ft.	2.75
24-in. culvert pipe, per lin. ft	3.75
30-in. culvert pipe, per lin. ft.	5.00
36-in. culvert pipe, per lin. ft.	6.50
1:2:4 concrete for box culverts, per cu. yd.	25.00
Metal reinforcement, per lb.	.09
Broken stone or gravel surfacing, per cu. yd.	1.75
7 in. cement concrete pavement, per sq. yd.	2.50
5-in. asphalt concrete pavement, per cu. yd.	1.80

Herbert Munn, Salem, Ore., is State Highway Engineer.

Washington.

HIGHWAY CONSTRUCTION IN 1921.

Type	Miles.	Average width surface.	Thickness Surface. In.	Thickness Base. In.	Ave. cost surface and base. Per mile.
Concrete	46	18, 20	1-course	7½, 6	$30,000
Crushed rock	86	11	1-course	7	*3,680
Grading	79	..	..	.	10,000
Bridges	..		..	.	†178,000

*Surfacing only. †Total br. const.

The amount available for 1922 construction is $6,500,000, of which $1,250,000 is for major bridges, $2,250,000 for 70 miles of concrete and the remainder for crushed rock roads and for grading.

James Allen, Olympia, Wash., is State Supervisor of Highways.

Nearly 50 Miles of Bridges Built by Government Aid.—More than $8,525,000 has been expended by the Federal Government, through the Bureau of Public Roads, United States Department of Agriculture, toward the building of bridges on Federal-aid roads and highways in 35 states during the 4 years and 4 months ending Nov. 1 last. That period dates back to the inception of the Federal-aid road work as at present supervised. Placed end to end, these bridges, each of which has been constructed in connection with the road work, would total 47.4 miles. Their estimated total cost is placed by the department at $20,235,200.13. It will thus be seen that approximately 42 per cent of the total cost was contributed by the Federal Government. The location of some of the chief projects and their total cost was as follows: Georgia, $2,950,474; New Jersey, $5,108,402; North Dakota, $1,306,384; Oklahoma, $2,280,769; South Carolina, $1,404,278; and Texas, $809,967.

Methods of Lighting Concrete Road Construction at Night

By R. I. BERNATH

[illegible] Surveyor, Williams County, Bryan, Ohio

Realization that the public would be largely benefited if paved roads were constructed faster and also that contractors would have an opportunity to make more money in a season has led to the introduction of larger road-building outfits which under favorable conditions do turn out much greater mileages. Another method of increasing output using the equipment on hand appealed to the contractors on the Wauseon-Bryan Road as being entirely practical, and they proceeded to put it into practice. Their plan was to keep the mixer operating for 16 hours a day, using two 8-hour shifts.

Concreting was begun on July 7 by Lewis & Copeland of Lima, O., who were contractors for the 6-mile job. Materials were hauled from the unloading station in large trucks and stored on the subgrade ahead of the mixer.

At first a single shift was used. About two weeks later another crew was added, and the hours changed so that one gang worked from 4 A. M. until noon, while the second worked from noon until 8 P. M. A third shift consisting of only three men was on duty for the remaining 8 hours of the night; one of these men sprinkled the curing concrete, a second was on duty at the pump, while the third edged the new slab, cleaned and oiled the mixer and did various odd jobs.

On good days, the combined output of the two crews was from 650 to 700 lin. ft. of 16-ft. reinforced slab having a uniform thickness of 8 in. This is practically double the amount of pavement placed with the single gang. The mixer was a 14 E Multifoote machine in which a 3-sack batch of 1:1½:3 concrete was mixed at a time.

The outputs of the two shifts were about the same, although the afternoon shift sometimes succeeded in going beyond the mark set in the morning. Work was not stopped for lunch, but the men ate part at a time as they could be spared. Laborers were drawn from the neighborhood and were largely farmers or men from the town of Wauseon who were not able to follow their occupations because of the prevailing business depression. They were allowed to change shifts weekly if they so desired, and no objection was raised to the unusual hours.

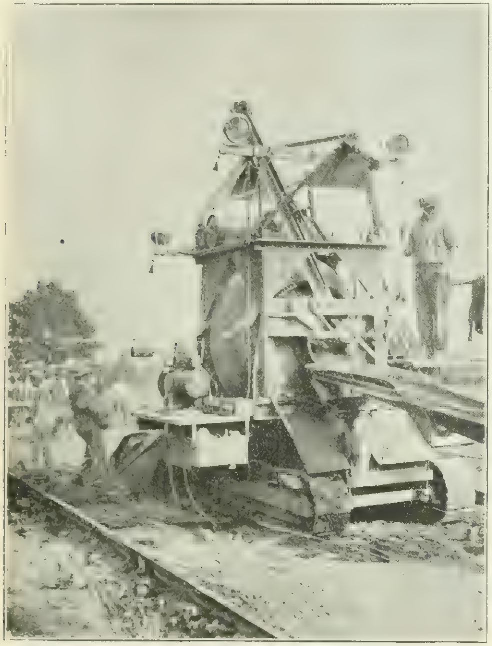
When the 2-shift plan was first put into effect, daylight lasted almost throughout the 16-hour period, and a few automobile lamps added sufficient illumination. Later it became necessary to have the work more fully lighted, so that the contractors purchased a 750-watt Willys light plant, consisting of an engine-generator unit and a storage battery. This set was mounted on a bracket at the left side of the mixer. The engine could develop about 1½ H.P., and the generator supplied electric current at 32 volts.

Night Scene on Construction of the Bryan-Wauseon Concrete Road in Fulton County, Ohio.

Illumination around the mixer for a radius of 50 to 75 ft. was furnished by four cluster lights, each having two 50-watt bulbs. These are known as Mazda lights with guards, which means that the filament in each is very short and is held in place by two small wires. Because of the vibration of the mixer, this type of filament is necessary. One larger light could be used instead of the two, but the large-size bulbs are more expensive in proportion to the illumination furnished. Four 6-volt automobile spot lights were also mounted on the mixer frame as shown in one of the photographs. One of these in front was thrown upon the left line of forms 100 to 150 ft. ahead, while the other was turned upon the materials, which were stored on the right side of the road. The two lights at the rear of the mixer illuminated the newly placed slab for the finishers. The four spot lights were connected in series, while the 50-watt bulbs were in parallel. The sockets for the latter can be seen just below the spot lights in the photographs, but the bulbs themselves were removed when not in actual use. They were protected by wire guards.

A ninth 50-watt bulb on a 20-ft. extension was used as a trouble-light; it had a switch of its own while all the other lights were on a master switch. It was needed in cleaning and oiling the mixer at night, and frequently was used by the formsetters, who had to set the right form just ahead of the mixer because materials were piled on that side of the road.

The generator was operated for about six hours a day, and the storage battery relied upon for the remaining time when light was needed. The generator was able to supply electricity for the entire lighting circuit and to charge the battery at the same time; the latter could operate the lights for six hours if necessary.



Light Plant on Side of Mixer. Drop Light Sockets Can Be Seen Below Spotlights.

Every 1,500 lin. ft., a standard 6-in. by 12-in. cylinder was made of concrete taken from the subgrade. This was then shipped to the State Highway Testing Laboratory at Columbus for testing at 28 days. Slump tests were made at frequent intervals, using the 12-in. truncated cone with 8-in. base and 4-in. top. As the work was hand-finished, a slump of about 2 in. was allowed.

In the construction of the 6.3 miles of pavement, 109 car loads of cement, averaging 223.3 bbls. to the car, were used. The concrete is a 1:1½:3 mixture, containing 1.91 bbl. cement to the cubic yard of concrete.

Two inspectors were used on the work—one for each shift. J. P. Shumaker, Division Engineer at Lima, was in charge of the job for the State Division of Highways, and the writer served as Resident Engineer.

Pennsylvania Lets $55,000,000 of Road Contracts in 4 Years.—According to the annual report of the State Highway Department of Pennsylvania, covering the years 1917, 1918, 1919 and 1920, the department in these four years let contracts for road construction totaling $55,207,923.

Modified Telford Base for Tennessee Highways

A modified telford base is now being used by the Tennessee State Highway Department of which D. Q. McComb is Chief Engineer, on some of its heavy traffic highways. This base is still in the process of development, as it has not been possible to secure, up to the present time, just as smooth a surface as could be desired. With this single exception, however, the Department is well pleased with the results it is now obtaining in the construction of this class of base, and has practically adopted this type of construction throughout the State, with the exception possibly of the extreme western portion of Tennessee, where no rock is encountered.

The method of constructing this base is set forth so clearly in the specifications that we are quoting them below.

HAND-PLACED COARSE STONE BASE.

Description.—This base course shall consist of a foundation course not less than 8 in. in depth, after compaction, constructed upon the prepared subgrade, of large stones, hand-placed, sledged, well interlocked and wedged in place by smaller stones, and the surface made smooth and uniform by the addition of crushed stone or gravel, in accordance with these specifications.

This base course is designed for use under plain waterbound macadam, bituminous macadam, rock asphalt and bituminous concrete surfaces, and other types of similar character.

Materials.—The material for this course shall consist of approved field or quarry stone, free from thin or slabby pieces, and free from disintegrated or unsound stone, clay, or other deleterious substances. The average depth of the larger stones, before napping, shall be only slightly less than the depth of the finished base course. The maximum width of the larger stones shall be not more than 10 in. and the maximum length not more than 16 in.

Method of Construction.—After the subgrade has been prepared as specified, wooden blocks whose heights are equal to the required depth of loose stone, shall be placed thereon at sufficient intervals to insure a uniform depth of the base course. Before rolling, these blocks shall be removed and the spaces occupied by them shall be filled with stone of the proper size and quality. The field or quarry stone shall not be dumped directly in place, but each large stone shall be placed by hand with the broad edge down and with the longer dimension at right angles to the center line of the roadway. They shall be laid perpendicular to the road surface, in close contact, and breaking joints insofar as is possible. The hand-placed stone shall then be sledged and broken in such manner that no flat or large rock surfaces or long edges of the hand-placed stone appear at the surface. All projecting points shall be napped off in such manner that the tops of the largest fragments shall be slightly below the elevation of the surface of the finished base course. The larger interstices shall be filled with spalls resulting from the sledging and napping, re-distributed by hand as may be necessary to secure an even, uniform surface conforming to line and cross-sections given. After the larger voids have been filled with the smaller stone, as above described, the course shall be rolled with an approved roller weighing not less than 10 tons until all stones are well bedded and tightly keyed together. Crushed stone or selected gravel, subject to the approval of the engineer, shall then be added to the course in sufficient quantities and in such a manner as to fill all remaining voids and even up all depression, after which the course shall again be rolled. The addition of crushed stone or gravel shall continue until the base course is thoroughly filled and compacted and a surface is produced that is true to the lines, grades, and cross-sections given.

When a rock asphalt surface course is specified, this course shall be followed, immediately prior to the application of the rock asphalt, by a layer of crushed stone meeting the requirements of No. 3 stone. This layer shall have an average depth of 1½ in. after compaction, and shall conform to the grades and cross-sections specified. It shall be rolled until thoroughly compacted with an approved roller weighing not less than 10 tons. Any irregularities appearing in the surface due to the rolling or other causes shall be remedied by the loosening and removal or addition of the No. 3 stone, after which the surface shall again be rolled to compaction. No traffic shall then be allowed on the completed surface prior to the application of the rock asphalt surface course.

For all other types of surface courses the layer of No. 3 stone shall be omitted, and, when so directed by the engineer, water shall be sprinkled over the surface in such amounts as may be directed, when the finer stone or gravel is applied. All holes or depressions produced by rolling or otherwise shall be filled with acceptable material and the surface re-rolled until it is thoroughly compacted and is uniform with the surrounding surface.

The napping, choking, watering and rolling of this course shall proceed within 1,200 ft. of the laying of the hand-placed stone except upon written permission of the engineer.

Resume of Federal Aid Work and Future Policies

Address by Thomas H. MacDonald, Chief, Bureau of Public Roads, Presented at the Meeting of the Association of State Highway Officials, Held at Omaha, Neb., Dec. 5 to 8.

That which has been accomplished through the co-operative efforts of the States and the Bureau, though it is of large consequence, in a comparative sense becomes but the background against which the new, the larger picture, of the future accomplishments, is projected.

We comprehend now as we have not understood in the past, the influence exerted upon our national life by transportation. It is the factor we find now interposed between supply and demand, between the starving thousands and food supplies, between producer and consumer. It is the factor whose absence separates, and whose presence ties together communities, states, and the nation as a whole. To supply adequate and increased transportation facilities is the motive which has influenced the American people to increase the number of motor vehicles in use since 1910 more than 1,800 per cent. To provide the complement of the motor vehicle, the improved highway, is the underlying reason why the larger funds have been made available from State and Federal sources. The proper combination of these two to serve a definite purpose in the nation's economy—this is highway transportation in the making.

Motor Vehicle Registration and Highway Funds. More enlightening than any statistical quotation is the graphic picture of motor vehicle registration and highway funds. The widespread opposition to State programs of highway building during the years from 1910 to 1916 when motor vehicles were pyramiding at an unforeseen rate, the increased funds made available following the Federal Aid act of 1916, the stagnation of actual expenditures during 1917 and 1918, the competition of industry of 1919 for materials, labor, and even more important, for rail transportation—all these have played a major part in producing the wide difference between the improved highways demanded by 9,300,000 motor vehicles and the actual new mileage constructed.

The record for 1920 and 1921 is better, but let each State highway department make plain to the people of its State that for less than three years of the past five since large funds became available, have conditions permitted highway construction on an increasing scale. The facts which are true of construction are true also of maintenance.

The charted figures of expenditures are not exact, yet such error as exists lies principally in those funds which are raised and used locally and which do not reach the principal highways or result in more than haphazard repairs of local roads. For the past several years, since every State has had a highway department, the figures are substantially correct as to all funds which are a factor in this discussion.

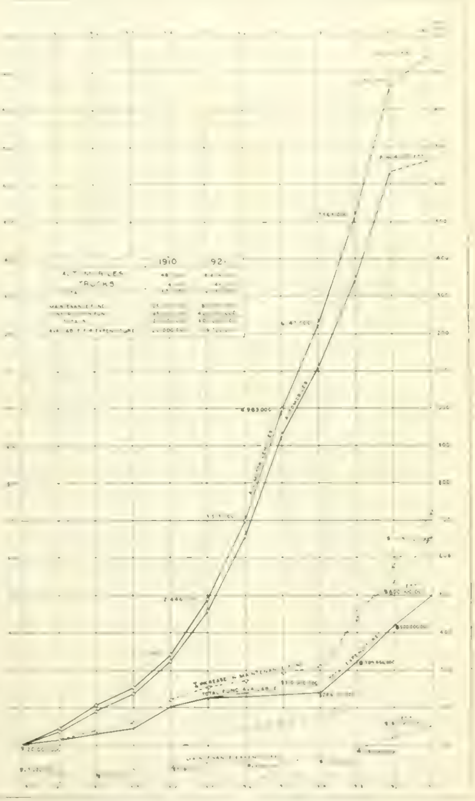
The conclusions are self-evident.

1. During the period 1910-1921, the potential number of motor vehicles demanding highway service increased more than 1,800 per cent; our actual expenditures for construction and maintenance increased about 400 per cent.
2. During the period 1910-1918, motor vehicles increased more than 1,100 per cent, highway expenditures about 140 per cent.
3. During the period of 1918-1921, motor vehicles increased about 700 per cent, and highway expenditures about 260 per cent of the 1910 figures.

But even these figures do not truly represent the differential between the demands for highway service and our actual production. Without attempting impossible refinements, if the cost index of 1918 be taken at two and that of 1910 at one, the actual increase in production of 1918 over 1910 was only 20 per cent, and if the index for 1921 is taken at 1½, the actual increase in production of 1921 is only about 233 per cent over the 1910 figure. That is, taken as a national aggregate, the number of motor vehicles, all at least potential users of the highways in some degree, has increased in 11 years since 1910 more than 18 times. Our greatest annual production of serviceable highways measured by the construction and maintenance expenditures has been not more than two and one-third times the production of 1910, and it has been only within the past three years that production has gone forward at a rate approximating the maximum.

It seems to me a duty as well as a very great privilege to bring before you this viewpoint, clearly defined against the background of fact, of our progress in the development of highway transportation and of the relationship of the highway organizations, State and Federal, to this development.

The Opportunities of Highway Engineers.—Those who are a part of these organizations have the good fortune to be engaged in their chosen field when the greatest development that can ever come is taking place. The first two or three years of something more than a decade of major road building have passed. What has gone before has been largely preparatory—a period of organization. What will come after—perhaps 10, perhaps 15 years later—must by then be largely standardized, largely routine. The highway organizations that come after will not have such opportunities to render good, or, equally true, bad services, or be able to progress so far in a limited time in advancing highway engineering and administration, and in combining the motor vehicle and improved highways into scientific highway transportation.



Motor Vehicle Registration and Highway Funds.

This body of individuals and their associates will determine the efficiency of the highway system of the future. Are you accepting the responsibility? Do you say to yourself, seriously and thoughtfully, "Upon my efforts in a large degree depend the future service the highways will render? If I yield to political pressure, to selfish interests, to some stubborn opposition, and fail to plan and to build the highways the people of my State ought to have, not only the present but succeeding generations must suffer."

This organization must awaken to a responsibility of placing before the public at large the real facts concerning highways and their relationship to highway transportation service. It must speak with authority and emphasis. It must take upon itself the serious responsibility of leadership in directing public thought and education, not by the arrogant methods of the demagogues, but by intelligent dissemination of facts and principles founded upon knowledge and experience. Nothing as big as the highway improvement program now actually under way is safe from attack through selfish, short-sighted or ignorant motives. Nothing will carry on the spirit and interest of the public through the long period ahead except an appreciation and a belief in the integrity and usefulness of the results accomplished.

I do not wish to fail in showing my belief and enthusiasm in the possibilities and opportunities that lie ahead of the highway organizations. But I wish less to fail to place upon the conscience of each individual, regardless of the rank he holds, his responsibility. I want to see this organization accept the fact that the success of the future highway program is dependent upon the character and ideals maintained by the component forces, and that the failure of any one of these, Federal or State, reacts adversely upon the whole.

Progress in Past Two Years in Highway Improvements.—It is not possible to define for a definite period of time the exact progress made for the United States as a whole, for there is no fixed point common to all the States. Yet, from the standpoint of highway service, I list our outstanding progress for the past two years in this order.

1. The increased highway service made possible through the establishment of proper methods and the expenditure of more adequate funds for maintenance.
2. The increased highway service resulting from new construction.
3. The adoption and enforcement of better engineering standards.
4. The improvement in the administration of highways as a public utility.

Although the new construction has been very large, the mileage of highways of all types that have been brought to a serviceable condition or restored after a period of inadequate repair, is still greater. The outstanding results secured from the distribution of the large quantities of war surplus materials and equipment are found in the better and more extensive highway maintenance made possible. The Bureau estimates that by the end of the year war surplus to the amount of approximately $150,000,000 in value will have been distributed for use in highway improvement.

Mileage, Types and Cost of Federal Aid Projects.—Without the details by states, as a national program the following shows the progress by years in placing new road work under way.

FEDERAL AID PROJECTS UNDER CONSTRUCTION AND COMPLETED—BY CALENDAR YEARS.

Calendar Years.	Estimated Cost. For year.	Estimated Cost. Accumulated.	Federal Aid. For year.	Federal Aid. Accumulated.	Miles. For yr.	Miles. Ac.
Previous to & inc. 1918	$18,088,000	$ 18,088,000	$ 7,568,250	$ 7,568,250	1,706	1,706
1919	119,746,270	137,834,270	52,210,105	59,778,355	8,071	9,777
1920	212,292,815	350,127,085	89,904,752	149,683,107	11,754	21,531
To Dec. 1, 1921	141,362,865	491,489,950	59,900,615	209,583,722	6,986	28,517

On Nov. 1, 1921, our records showed the following mileage and costs of roads completed and under agreement:

MILEAGE AND TYPES COMPLETED AND UNDER AGREEMENT NOVEMBER 1, 1921.

Type.	Cost. Total.	Cost. Federal Aid.	Mileage.
Graded and drained	$ 55,704,253	$24,721,021	6,864
Sand clay	22,226,362	10,195,172	2,696
Gravel	104,614,067	47,192,895	10,044
W. B. macadam	22,152,779	9,729,201	1,291
Bituminous macadam	41,412,557	18,612,066	1,323
Bituminous concrete	23,445,377	9,299,861	772
Concrete	184,021,245	75,600,279	4,654
Brick	22,009,847	6,925,483	444
Bridges	20,335,200	8,525,395	*47
Totals	$496,151,683	$211,195,776	28,135

*Includes approaches.

The distribution of costs and types on a percentage basis for the projects summarized are as follows:

PERCENTAGES OF TYPES—PROJECTS COMPLETED & UNDER AGREEMENT AS OF NOV. 1, 1921.

Type.	% Est. Tot. Cost.	% Federal Aid.	% Tot. Mileage.
Graded and drained	11.2	11.7	24.4
Sand clay	4.5	5.0	9.6
Gravel	21.2	22.4	35.7
W. B. macadam	4.5	4.6	4.6
Bituminous macadam	8.3	8.8	4.7
Bituminous concrete	4.7	4.4	2.7
P. C. concrete	37.1	35.8	16.5
Brick	4.4	3.3	1.6
Bridges	4.1	4.0	0.2
	100	100	100

As of Nov. 25, the records of the Bureau show that of the total allotments to the States under the two first appropriations, $266,720,000 there has been placed under agreement with the States Federal Aid funds in the sum of $213,048,000 for 28,491 miles of highways. Of this mileage there has been completed the equivalent of 21,000 miles. You will note, therefore, that there now remains the balance of $53,702,000 to be placed under agreement from the old appropriation. From the new Federal Highway Act appropriation of Nov. 9, there has been apportioned to the States $24,575,000, available now, and $48,750,000 available January 1, 1922.

Opportunities Under New Federal Highway Act.—As a foundation for the consideration of future policies under the new legislation, the Secretary of Agriculture has authorized and requested me to express clearly and without reservation his position that in the formulation of the new rules and regulations required, and in the administration of the law, the department will request the counsel of this association through its proper committee. The secretary is greatly impressed with the possibilities and responsibilities of the new act, and the truly co-operative spirit which must underlie the functioning of both the state and federal organizations to make the greatest and surest progress.

The act itself is remarkably comprehensive in defining and demanding a systematic plan, national in its extent, for future highway development. None of us have had, or are ever likely to have a more serious responsibility than the one imposed of selecting the Federal Aid system to be composed of the most important highways, articulating not only within the states, but with the systems of the contiguous states. Here is an opportunity to do a big, basic work, such as comes to few in the course of a life-time. The individual who fails to vision the importance of the task has no moral right to hold a position of authority in its performance. From a conception of highways as a purely local institution, a viewpoint we held for over a half century of our national life, we progressed to an acceptance of their importance to the state. This attitude persisted for another quarter of a century, until, through the universal use of the motor vehicle, the transportation crisis of a great war, the repeated threats of extensive railroad tie-ups, and the results already secured with Federal Aid, we have, in the short period of five years, visioned our more important highways extended and interconnected to form a vast network, serving local, state and national traffic, only limited by the confines of the United States. This is the conception which has been written into the law, and which, because of the projected effect of that which is done now into the future, lifts the importance of this requirement, that is, the selection of the Federal Aid system, above any other principle or duty therein announced.

Highway Construction as Relief for Unemployment.—This work must not be hurriedly done, but because of the unemployment situation urgently demanding every possible relief that may be obtained through the highway program, projects will be approved without delay for the building of roads which the states and the district engineers of the bureau agree will lie upon the Federal Aid system. Each district engineer is fully informed as to the procedure for "interim" projects, which is so simplified that if important projects are chosen in good faith there will be no delay in securing favorable action.

The department will do everything possible to expedite projects that can bring any relief from the unemployment crisis now, or that will shorten the winter season of inactivity in road building in the northern states. The revised regulations will not be issued until they have been considered in detail with the representatives of the association.

Considerations in Choice of Highway for Major Traffic Lines.—There can be no doubt as to the clear intent of the law to provide for a system of roads which shall include those which are now and which after improvement are to become the major traffic lines. The different states of improvement to which the states have progressed, and all the variations between them of topography, of population distribution, of industries, of development of natural resources, must necessarily be reflected in the laying out of the system. These details must be worked out between the states themselves and between the states and the Bureau of Public Roads. Because of these wide variations, it is only possible to suggest some of the major considerations. We do not minimize the importance of the local traffic. To care for this class properly will in general, always be the first objective of highway improvement. Our conception is rather that a choice of highways shall be made which, regardless of the order of improvement, will eventually join into a well conceived network crossing both county and state boundaries. Thus, while the immediate needs of a state or a district may determine priority of construction, each new link brings nearer the completion of the system as a whole.

In the western states the major routes will be largely fixed by topography, but by the same token, because long routes will be determined by single strategic points such as a mountain pass, it is the earnest hope of the bureau that the states affected will reach an agreement based on the future service that is to be rendered, not only to the local, but also to the inter-state and national traffic.

In the same spirit that the United States by a courageous and generous policy has made possible definite progress in the limitation of armaments, to be followed by a consequent decrease of national expenditures for potential destruction, it is my sincere belief that the highway organizations will make possible through mutual agreement the consummation of a splendid national system of highways. This comparison is not lightly made, for the program ahead involves hundreds of millions of dollars, but with this essential difference, that this huge expenditure will be for a constructive, nation-building purpose. In the great agricultural districts where the major road development is still ahead, and where the connecting up of continuous routes will at the same time serve the local traffic equally with other projects, it is hoped that the states will recognize that duty imposed upon the department, expressed in the language of the law, "The Secretary of Agriculture shall give preference to such projects as will expedite the completion of an adequate and connected system of highways, inter-state in character."

In the eastern states, some of them with a large mileage of improved roads, it might appear that the selection of a system is not so important, yet it seems to me that it is here that our greatest traffic problems lie. It will be a comparatively short time, because of new construction and better maintenance, until the trans-continental tourist will be provided with roads that are entirely serviceable throughout the seasons of the year when other conditions favor such travel. The really serious traffic problems lie around and between large centers of population. It must be remembered that for roads built previously many engineering details such as alignments, widths, types, were planned prior to the advent of the motor traffic, and for the slower, lighter, horse-drawn vehicle use. The consideration of weight, speed, safety, numbers, which now must govern design, had not yet become the controlling factors. The traffic lines are from town to town, and in general follow through the most congested parts of population centers.

Principles That Must Be Worked Out.—As some of the principles which we must properly work out, the following are suggested:

1. The development of parallel lines to divide heavy traffic through thickly populated districts.
2. The development of direct, short mileage routes, although on these routes there may now be a less amount of improved roads than on routes now followed.
3. The building of inner or outer belt lines around congested centers.
4. The reconstruction of weak sections for heavy truck traffic.
5. The widening of main routes near the largest cities or between cities where the distance is short enough to carry uniform traffic.
6. Proper connections with the routes of adjoining states.

Possibly there are many questions as to the future surfacing policies. The changes in types and specifications which will be sought from time to time by the bureau will be based upon the more accurate knowledge which is being obtained rapidly through research and through the detailed studies of the behavior of modern designs under traffic. The requirement of the 18-foot surfacing is construed to mean that this is fixed as the minimum two-way road, where the construction is to be considered complete as first put down. This requirement will not preclude the building of a narrower pavement in those districts where the traffic does not yet justify the two-way width. I am yet to be convinced that we may not properly build now in many sparsely populated districts one-half of the final width of pavement in order to complete mileage between points, if all the other work is done to provide for the full width construction later.

Maintenance Requirements in New Law.—To insure maintenance, the strongest possible requirements have been written into the law. The department may not slight its responsibility, and the attitude of the whole national administration demands the utmost fidelity in the continuous upkeep of the highways built. The position taken by the president in his published addresses is well known. His statements to the executive committee of this association, who counseled with him while the present legislation was under consideration, the statements of the Secretary of Agriculture in presenting the completed legislation to the president for his signature, all leave no possible doubt as to the position which must be taken by the bureau in enforcing the provisions as to maintenance.

We are not left in doubt as to the meaning of the word "maintenance." The law itself states, "the term maintenance means the constant making of needed repairs to preserve a smooth surfaced highway." Further, "such State shall make provision for State funds required each year * * * for construction, reconstruction and maintenance of all Federal Aid highways * * * which funds shall be under direct control of the State Highway Department."

The bureau earnestly hopes that it will not be required to take over a single mile of highway for maintenance, but the responsibility is imposed, and this provision of the law will be enforced to the letter. It is a well established principle that proper maintenance will result only if some form of patrol is organized that places direct and continuous responsibility upon some one for the condition of each mile of road, and the bureau will not consider that the states are properly living up to the requirements of this act until such a system is established. I do not use "patrol" in the technical sense to distinguish it from the so-called "gang" system, but rather, the proper combination of patrol and gang systems to meet the particular conditions of each state. If there is one word to be accented more than any other, it is the term "constant," and to this should be added "automatic."

Personally, I am more than delighted that the sliding scale has been established to gauge the co-operation required in the public land states. I do not regard the establishment of this scale as a concession to the west. It seems to me to be only a proper and just recognition of the responsibility which the United States as a whole must shoulder—that of improving those highways necessary through the public lands whose future utility is problematic.

It is not necessary to touch upon all the points of the law. I have endeavored to accent the establishment of the system of Federal Aid roads as beyond all other principles, the most important written into this law. Of only slightly less importance is the requirement as to maintenance. While our thoughts may run to large construction programs, and the details of types and materials to be used, let it be remembered that we are providing highway service, and that the degree of service rendered is determined by the lay-out of the system, and by the condition in which every mile of road within that system is maintained constantly. Every state which has established a state system of highways has found those highways almost immediately abandoned by the counties or other local subdivisions. I trust that each state in which highways are taken into the Federal Aid system, which have not up to this time been established as state highways, but have been under the jurisdiction of the local boards, will recognize this principle and make immediate plans under which all parts of the system will come under the jurisdiction and maintenance of the state without waiting for their construction.

Mutual Responsibilities of State and Federal Organizations.—The Bureau of Public Roads will proceed under the provisions of this act on the assumption that each state will recognize the mutual responsibilities imposed upon the state and upon federal organizations, and will bring its operations at once into harmony with all the provisions. Also, that each state will in fairness recognize the greater responsibilities, restrictions and requirements imposed upon the federal bureau. The bureau does not seek initiative. It does not seek to direct the states but to co-operate with them. There is now a plan of action for the guidance of both organizations that is so clear and so explicit that neither can escape the responsibilities imposed. The federal requirements are fairly defined and will be sincerely and faithfully enforced. Among all of the 48 states, I know of no cases where it is not possible to co-operate fully—certainly no physical or financial difficulties are insurmountable—and if difficulties develop in the administration of this law, they will come from a wrong attitude of mind on the part of one or both of the organizations. We can and will eliminate any possibility of such only through a mutual consideration and respect each for the viewpoints and obligations of the other.

Public Misconception of Service Rendered by Highways.—It is evident that a great misconception exists in the public mind as to the service which is being rendered by the highways. During the very long period that construction and maintenance were lagging far behind the increase in traffic, it is not to be wondered at that our highways showed a material depreciation. Through the war period, with the greatly increased use of heavy traffic units, particularly at just the season of the year when the road surfaces are carried on weakened subgrades, some roads did break up seriously. But this depreciation in general has not continued, and more than this, the effect of the lag in maintenance has been practically obliterated by the increased maintenance during the past three years, and by the reconstruction of the weaker sections, until our roads are in a far better condition today, than they have ever been in our history. This fact in itself controverts successfully any general accusations against our modern highways, of failure to carry the loads imposed. Think of the conditions in your own state. Are not the roads far better than they have ever been? And yet perhaps many of you feel that in some other states the roads have been and are depreciating rapidly. I have been unable to find such evidence. Roads that during the war, because of unusually heavy traffic and lack of maintenance, were seriously depreciated, have since been brought back into a state of better repair than they have ever been. Cheaply constructed roads, roads that were built before any consideration of present-day traffic, are being held up through adequate maintenance on some of the heaviest traffic lines in the country.

Legislation for Regulation of Highway Traffic.—The whole purpose of highway building is to make possible highway transportation, and the cost of the transportation must be reduced as low as possible. Therefore, restrictive legislation which limits too greatly the loads to be hauled on the highways should not be tolerated, as it is against a proper public policy. Legislation regulatory of the traffic on the highways should take into account that there are many factors which govern the traffic depreciation of our highways.

Laws which blindly fix some maximum weight to be moved on the highways may prohibit the really profitable traffic and allow less economical and more destructive vehicles to operate practically unchecked. Both weight and speed are major factors in their destructive effects upon the highways, but the distribution of the load, the relation of the sprung and unsprung weights, the tire equipment—all have an important effect.

From the research of the past two or three years, and from the practical experience of the highway engineers, we are accumulating sufficient knowledge to engage understandingly on a determination of the character of legislation which will result in a sound public policy. The solution of highway transportation lies in the proper adjustment, no less of the motor vehicle to the road than of the road to the motor vehicle.

I hope to see no conflict develop between the states in the determination of traffic regulations. Such would destroy in a large measure the utility of a Federal Aid system of primary highways. Rather, because the system will for a long time be non-uniform in its carrying capacity, much discretion should be allowed the state highway departments in determining the loads which are to operate upon specific sections of highways, and further, much discretion should be allowed the departments in the making of seasonal restrictions where climatic conditions are such that there are periods when the roads normally fully capable for carrying heavy loads, are for a short time carried on uncertain subgrades. Here is an opportunity for the highway builder and the motor truck manufacturer to co-operate to serve the public's interest.

Preserving Major Part of Original Investment in Highways.—One other point is causing the public much concern. It is often stated that highways have gone to pieces and must be rebuilt. Engineers have been prompt to develop methods of improvement which are salvaging practically the full value that was originally invested in the highways. For example, some of the older macadam roads in New York State, lightly built, which are now heavy traffic lines, have been widened by concrete roadways on either side preserving a strip of macadam, say 6 ft. wide in the center, thus giving a 24-ft. usable surface by the addition of 18 ft. of new construction. The remainder of the macadam width is scarified and the material spread to form a better base under the new construction.

This is only one example of so many successful operations of like reconstruction that it may be taken as a principle that if roads are well maintained when traffic becomes so heavy that reconstruction is necessary, the major part of the investment can be preserved and be built into the new highway as an integral part. It is my judgment that our heaviest traffic lines of the future will be developed in this manner, for we must recognize the principle that at the present time the big task is to get a mileage of surfaces that can be maintained under the traffic. Perhaps the principle that we should remember is to do the fundamental work right. Road surfaces are built for use and we must expect them to wear out. The one thing that we must do is to furnish highway service, for this is an essential factor of highway transportation, and we must rely on highway transportation to pay the major portion of the costs of the whole construction and maintenance program ahead.

State Highway Officials Endorse Bill Appropriating $100,000,000 for Federal Aid.—The American Association of State Highway Officials at its annual meeting at Omaha, on Dec. 8, unanimously adopted a resolution endorsing the action of congress in adopting a policy of federal aid for highways, to be applied to a definite system of highways as provided in the Federal Highway Act, which went into effect Nov. 9, 1921, and pledged its hearty and unqualified support to the Federal Bureau of Public Roads in carrying out the provisions of the act. The resolution further states:

> Inasmuch as the Act contemplates continued Federal participation with the states in highway improvement, we realize and emphasize the absolute necessity of a definite policy projected far enough into the future to make possible the economic and satisfactory planning and carrying out of the intent and purpose of the Act.
>
> To this end we endorse H. R. 8978 introduced by Hon. Roy Woodruff, which bill authorizes the appropriation of $100,000,000 annually for five years beginning July 1, 1922, as a general Federal Aid Appropriation, and we also urge that adequate provision be made in the said bill for the continued development of highways in and adjacent to the forest areas and Indian Reservations under unified control.
>
> The adoption of this five year program is necessary to enable the states, through their legislatures, to make proper provisions for the requisite state co-operation in this enterprise

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Short Course in Highway Engineering at University of Pennsylvania.—A brief course in highway engineering will be given by the University of Pennsylvania from Jan. 23 to Feb. 10. This course is planned for men who have had technical training and who have had practical experience in the construction of highways. The greater part of the instruction in the class-room and the laboratory is given by experienced engineers now engaged in the actual design and construction of roads and pavements. Courses 1 to 5 are given by means of lectures, while courses 6 to 12 are laboratory courses. The first session of the brief course in highway engineering given a year ago was attended by 67 men. These men varied in age from 19 to 59 years, with an average age of 30 years. More than half of the men were technical graduates and many were members of the American Society of Civil Engineers. The result of this course was very satisfactory and the second session is given at the suggestion of the state highway departments that have had an opportunity to test the results of the first course.

Data on Truck Operations and Construction Costs of Concrete Pavement in Sioux County, Iowa

By THOS. J. LOUGH,
Resident Engineer, Iowa State Highway Commission

During the summer of 1921, 2.2 miles of 18-ft. concrete pavement were constructed on that portion of the North Iowa Pike which runs west from Hull, Ia. The paving is 8 in. and 7 in. thick, respectively, at center and edges and is reinforced with 21 lb. of corrugated bar reinforcing per 100 sq. ft. The aggregate consisted of pit run gravel which ran about 80 per cent sand. The quantity of cement used varied according to the weight and the percentage of sand in the gravel, tests of which were made hourly. The average mix was 1 to 3.25.

While neither unusual features nor phenomenal runs may be recorded, still the following data on operations and costs may be of interest.

The construction equipment was as follows:

2 21-cu. ft. mixers.
[illegible]
1 10-ton road roller.
1 [illegible] pump.
1 6-ft. blade grader.
[illegible] dump body trucks, 1 ton and [illegible] wagons.
1,000 lin. ft. 7-in. steel forms.
2.5 miles of 2-in. pipe line.
[illegible] wheelbarrows.
Small tools.

The two mixers were set up side by side and adjacent to the railroad siding in the town of Hull. The aggregate was shipped in by train and unloaded by hand directly from the cars to the stock pile behind the mixers. The gravel was wheeled from the stock pile to the mixer skips in barrows and at no time was the wheeling distance greater than 50 ft. The cement was hauled by teams to the mixer as needed, either directly from the cars or from the storage sheds. Water was obtained from the city mains and was carried in a 2-in. pipeline to the sub-grade and to the mixer.

The number of trucks used during the job varied from 2 to 13. They were of various makes and of 1 and 2-ton capacity. All were equipped with wooden dump bodies and hand hoists. The 1-ton trucks usually carried 29.25 cu. ft. of wet batch and the 2-ton trucks 39.0 cu. ft. of wet batch per trip, and were thus considerably overloaded. The trucks were hired by the contractor on an hourly basis.

The organization of the crew and the rates of pay were as follows:

Concrete Just Before Final Belting.

No.	Title or Duties.	Rate per hour	Totals per hour.
	Stock Pile Mixing Plant—		
1	Foreman	$1.00	$1.00
2	Engineers	.67	1.34
2	Firemen	.40	.80

The Mixing Plant Showing the Two Mixers in Operation, the Stock Pile and Cars of Gravel on Siding.

2	Mixer operators	.40	.80
6	Gravel wheelers	.40	2.40
6	Gravel shovelers	.40	2.40
4	Cement handlers	.40	1.60
1	Cement sack baler	.30	.30
2	Concrete shovelers on trucks	.40	.80
1	Water boy	.15	.15
	Hauling Cement		
2	Teams and drivers	.80	1.60
2	Cement unloaders	.40	.80
	Subgrade		
1	Foreman	1.00	1.00
2	Finishers	.95	1.90
4	Concrete spreaders	.40	1.60
2	Wetting down pavement	.40	.80
4	Covering with earth	.40	1.60
2	Tamping and shaping subgrade	.40	.80
1	Wetting down subgrade and canvass	.40	.40
1	Roller engineer	.60	.60
2	Form setters	.45	.90
1	Removing forms	.40	.40
1	Team with driver hauling forms, blading sub-grade	.80	.80
1	Helper hauling forms, blading subgrade	.40	.40
1	Water boy	.15	.15
	General		
1	Timekeeper	.40	.40

Total hourly payroll of all labor and teams, exclusive of trucks and drivers ... $2[illegible].74

Table I gives truck performance and linear feet of pavement poured for each working day, and truckage cost per square yard of pavement:

TABLE I—TRUCK PERFORMANCE

Date 1921		Hours worked	Haul, miles	No. trucks	Total No. trips	Avg. No. trips per truck per hour	Avg. mileage per truck per hour	Total No. batches	Size of batch cu. ft.	Cu. ft. hauled per truck per hour	Lin. ft. of paving poured
June	28	9	0.62	2	55	3.06	3.79	330	6.50	119	186.6
	29	10	0.58	2	63	3.15	3.66	378	6.50	123	213
	30	3	0.55	4	54	4.50	4.95	212	6.50	115	107
July	1	10	0.50	6	146	2.44	2.44	632	6.50	68	381
	2	9	0.92	6	167	3.09	5.69	734	6.50	88	415
	5	5	0.86	7	88	2.51	4.32	327	6.50	61	218
	6	10	0.79	8	194	2.42	3.82	820	6.50	67	468
	8	6	0.72	10	128	2.14	3.08	558	6.50	61	281
	9	5	2.41	10	77	1.54	7.52	361	6.50	47	178
	12	10	2.37	13	190	1.46	6.92	880	6.50	44	472
	13	5	2.31	13	84	1.29	5.96	391	6.50	39	215
	14	5	2.28	9	63	1.40	6.38	298	6.50	43	165
	15	10	2.22	12	174	1.45	6.44	795	6.50	43	417
	16	8	2.11	12	147	1.53	6.55	662	6.50	45	364
	18	8½	2.08	10	104	1.22	5.08	456	6.50	35	252
	19	10	2.02	12	146	1.22	4.93	480	9.75	39	384
	20	10	1.94	9	147	1.63	6.32	500	9.75	54	401
	21	10	1.86	9	174	1.93	7.18	578	9.75	63	470
	22	10	1.77	9	171	1.90	6.73	570	9.75	62	451
	23	3	1.72	9	59	2.18	7.50	200	9.75	72	166
	25	5	1.68	10	99	1.98	[illegible]	317	9.75	62	265
	27	[illegible]	1.62	10	95	[illegible]	6.16	319	9.75	62	276
	28	3	1.58	10	66	2.20	6.95	218	9.75	71	172
	29	5	1.54	9	108	2.40	7.39	360	9.75	78	310
	30	9	1.46	10	198	2.20	6.42	635	9.75	69	527
Aug.	2	10	1.35	10	220	2.20	5.94	727	9.75	71	581
	4	10	1.25	10	176	1.76	4.40	574	9.75	56	465
	5	5	1.18	10	95	1.90	4.48	312	9.75	61	245
	6	4	1.14	10	96	2.40	5.47	316	9.75	77	270
	8	10	1.05	[illegible]	228	[illegible]	5.31	751	9.75	82	629
	9	10	0.94	8	195	[illegible]	4.59	653	9.75	80	535
	10	2	0.88	8	36	2.25	3.96	122	9.75	74	96
	11	10	0.82	8	215	[illegible]	4.41	720	9.75	88	565
	12	8½	0.73	8	159	2.34	3.42	528	9.75	76	423
Total	34	263	47.81	302	4,417	72.25	184.81	16,717	....	2,295	11,596.6
Av. per day		7.74	1.41	8.88	130	..	.....	492	8.31	.....	341.1
Av. per hour						[illegible]	5.44	66.1	.	67.5	45.8

Total square yards of paving ... 23,193.2
Total number truck hours ... 2,236
Total cost of truckage @ $2.00 per hour per truck ... $4,472.00
Equals per sq. yd. of paving ... $0.193

Costs of materials were as follows:

Cement:

Cost per sack of cement, net	$0.65
Sacks used per square yard of paving	1.77
Cost per square yard of paving	$1.15

Gravel:

Gravel per ton at pit	$0.70
Freight per ton	$0.475
Unloading @ $5.00 per car, per ton	$0.091
Cost of gravel at mixer per ton	$1.266
Or per sq. yd. of paving	$0.353

Water:

Location and use.	Total used cu. ft.	Per sq. yd. of paving cu. ft.
At mixer for concrete, loading, washing and trucks	32,785	1.41
On subgrade, road-roller, wetting down subgrade and finished pavement	[illegible]	1.52
Total	[illegible]	[illegible].93

[illegible]

[illegible]	$13.00
[illegible]	22,600

[illegible]

Sub-grade Treatment Experiments of California Highway Commission

Different methods of subgrade treatment are being carried out on various state highway contracts in California. These experiments consist in some cases in treating the adobe or clay subgrade with a light asphaltic oil; in other cases, a sand cushion is being laid and in other cases a gravel foundation. In order, however, that a direct comparison might be secured between the various methods of subgrade treatment which have been suggested from time to time, a decision was made to make such experiments on contiguous sections on the same contract. A section in Solano County between Denverton and Rio Vista, where the adobe subgrade conditions were considered particularly bad, was selected for the test. A gravel treatment of the subgrade has been adopted throughout on this section where not otherwise treated as described below.

A section 4,500 ft. in length has been divided into nine sub-sections, each 500 ft. long.

After the contractor has completed the rough grading, including the shaping but not the rolling, the grade to a width of 21 ft. when thoroughly dry will be plowed with a rooter or sub-soil plow until the soil is loosened to approximately the depth to be treated, after which it will be thoroughly harrowed, disked or rolled until the soil is well pulverized. After the soil has been thoroughly pulverized, these nine 500-ft. sections will be treated as follows:

Section 1. This section to be treated to a depth of approximately 12 in. Portland cement in the ratio of 1:10 of soil will be broadcasted as uniformly as possible over the harrowed surface; the subgrade will then be plowed and thoroughly harrowed and this entire operation of harrowing and plowing repeated, if necessary, to secure a reasonably intimate and uniform mixture of the Portland cement with the soil. If necessary, rolling will be done at this stage, followed by a spike tooth drag.

After having incorporated the cement with the soil, the subgrade will be rolled and finished to the same extent as the contractor would in preparing it to place his header boards.

Section 2. The same process will be followed as for Section 1, except that the proportion of cement will be 1:20.

Section 3. The same process will be followed as for Section 1, except that the depth of treatment will be 6 in. instead of 12 in.

Section 4. The same process will be followed as for Section 2, except that the depth treated will be 6 in. instead of 12 in.

Section 5. The same process will be followed as for Section 1, except that hydrated lime in the proportions of 1:20 of soil will be used in place of the cement.

Section 6. The same process will be followed as for Section 1, except that pulverized limestone in the proportion of 1:20 of soil will be used in place of cement.

Section 7. The same process will be followed as for Section 1, except that no foreign substance will be mixed with the adobe soil.

Section 8. The same process will be followed as for Section 1, except that 60 per cent asphaltic road oil will be spread at the rate of 3 to 5 gal. to the square yard.

Section 9. The same process will be followed as for Section 8, except that the depth treated will be 6 in. instead of 12 in.

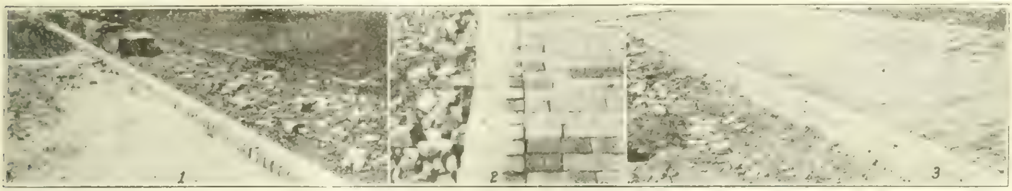
One of the principal objects of this series of experiments is to determine what effect a weak mixture of Portland cement, lime, or other material will have in correcting the tendency of adobe or clay sub-soil to absorb water and become plastic, thus creating a weak foundation condition in wet weather, with the resultant failure of the pavement under heavy traffic. A thorough study will be made both of the actual results of such treatment from a construction standpoint and also the cost of treatment and consequent value thereof from an economic standpoint. The work has just been started, but as the rainy season has now commenced, it is not expected that the work will be completed before some time next spring.

Brick Header Curbs for Brick Pavements

By H. FRANK DORR
County Engineer, Cambria County, Ebensburg, Pa

Cambria County, Pennsylvania, in the heart of the Allegheny Mountains, is carrying out a very extensive program of road improvement. Vitrified brick has been specified on all the roads built under county and township supervision, as well as on nearly all the state highway department roads in the county.

Practically all the brick roads are of cement grout filler construction on concrete base and have been built in the past with concrete header curbs varying in width on each side of the road from 6 in. to 1 ft. On a recent job, however, Township Engineers O. E. Schlicker and Fred Hogan, the Barr Township Board of Supervisors, and the writer, considered building the edging curb of vitrified paving brick the same as the balance of the road. A road in Barr Township being built by the Bell-Bockel Co. of Johnstown, Pa. originally designed for concrete base and header curb, sand bed, and brick 4 in. in depth was selected. The specifications were changed to call for brick 3 in. in depth, granulated slag bed, and brick header curb with the concrete base.



Details of Brick Curbs for Brick Pavement Constructed in Barr Township, Cambria County, Pennsylvania.

(1) Brick laid for curbing as headers 8½ in. in width by 4 in. in depth. The joints have been filled for only about half their length. The remainder of the joint will be filled with grout when the paving is complete and will provide a bond between the curb and the balance of the pavement. (2) Pavement surface after the brick have been laid and rolled just before the grout is applied. No attempt is made to have the courses line up with the brick in the curb. (3) Outside of curb and base showing monolithic construction.

The concrete base was laid as before, but the forms were set to line and grade at just the height of the base course. The base was then poured and struck off to proper form. Immediately after the base was poured and before initial set had taken place a thin layer of 1 to 1 mortar was prepared and spread over the concrete a sufficient distance from the edge of the base course to provide a mortar bed in which to set the brick curbing. A vitrified paving brick 4 in. in depth was used to make this curb. On one section of the road the brick were laid crosswise as headers forming a curb 8½ in. in width, while on the other section the brick were laid lengthwise as stretchers forming a curb 3½ in. in width. The 1 to 1 mortar was used to fill and seal the joints of the brick. The construction thus produced a monolithic brick curbing.

The strength of this construction and the proof that the curbing would not separate from the base course was well shown when on a number of occasions during the construction of the pavement loaded trucks had occasion to be driven over the curb, and in several instances trucks have accidentally run into and over the curb without, in any instance, breaking the bond between the brick curb and the base. Neither was the curb damaged or loosened during the rolling of the pavement even though the roller rode on the curb.

In another instance on a nearby road of similar construction it was found necessary to relocate a short section of the road after the curb had been constructed. Even though sledges were used to destroy the existing construction it was found that the brick itself would break rather than separate from the base.

After the base course and the curbing had been allowed to set and harden for about two weeks a bed of granulated slag was spread to a depth of no more than 1 in. (after rolling) and the pavement of brick 3 in. in depth then laid, rolled and grouted.

Longitudinal expansion joints along the curb line were not used, it being felt that they were not an absolute necessity and their use was a possible source of trouble. The pavement thus built gives the road an 18 ft. vitrified brick wearing surface across the entire width.

This work was under the supervision of the writer. Bell-Bockel Co. of Johnstown and Altoona, Pa., were the contractors. Charles E. Schlicher of Spangler, Pa., was engineer for Barr Township. Vitrified paving brick were of the wire cut lug type.

Daily and Average Footages on a Concrete Road in Wisconsin

Some interesting records were made on the construction of 4.7 miles of concrete road between Watertown and Johnson's Creek, Wisconsin. Peppard, Burrill & Connell of Minneapolis were the contractors. Work was started July 6 and finished Sept. 6, 1921, the total number of actual working days being 40.

The sand and gravel, which were shipped by rail, were unloaded by a crane and clam shell into two large stock piles, from which they could be loaded quickly into the respective bins of the combination hopper and measuring box. The materials were hauled in 3 cu. yd. trucks directly from the bins to the mixer.

The handling and hauling equipment were of Kissel make, the hopper and measuring box being a patented combination, with bin capacities of 20 cu. yd. of stone and 10 cu. yd. of sand. There were 9 Kissel road builder trucks of 3 yd. capacity each. Loaded trucks were turned at the mixer on a table especially designed by the same manufacturers.

Drivers were relieved of the care of trucks, a special mechanic being assigned to this duty, which included all greasing and oiling. All trucks were thus in proper operating condition as they went onto each morning's work, and it is believed that this was a substantial factor in the success of the job.

The total length of road was 24,816 ft., and the average footage completed in each of the 40 working days was 620.4 ft. The highest single day's record was 903 ft., on Aug. 24. From Aug. 1 to Sept. 6 inclusive, 21 full days were worked, the total pavement laid being 15,447 ft., or an average of 736 ft. daily. The record of this period follows:

Aug. 1—Rain
Aug. 2—Rain
Aug. 3—570 ft.
Aug. 4—742 ft.
Aug. 5—711 ft.
Aug. 6—723 ft.
Aug. 7—Sunday
Aug. 8—845 ft.
Aug. 9—813 ft.
Aug. 10—Rain
Aug. 11—Wet Road
Aug. 12—620 ft.
Aug. 13—618 ft.
Aug. 14—Sunday
Aug. 15—827 ft.
Aug. 16—498 ft. (a)
Aug. 17—Rain
Aug. 18—352 ft. (b)
Aug. 19—615 ft.
Aug. 20—Rain
Aug. 21—Sunday
Aug. 22—681 ft.
Aug. 23—711 ft.
Aug. 24—903 ft.
Aug. 25—794 ft.
Aug. 26—700 ft.
Aug. 27—866 ft.
Aug. 28—Sunday
Aug. 29—855 ft.
Aug. 30—318 ft. (b)
Aug. 31—Rain
Sept. 1—Wet Road
Sept. 2—520 ft.
Sept. 3—645 ft.
Sept. 4—Sunday
Sept. 5—Labor Day
Sept. 6—520 ft. (c)

(a) Rain—6 hr. work only.
(b) Rain—4 hr. work only.
(c) End of job—6 hr. work only.

Trees Hold Drifting Sand.—In many countries, but perhaps most notably in France, sands and other light soils have been stopped from drifting by the planting of trees and shrubs in suitably located belts. The kind of trees for use is governed by the character of the soil, amount of moisture, etc.; and in general should be referred to a skilled horticulturist for determination.

Safety and Beauty as Factors in Road Design

Abstract of a Paper Presented by A. R. Hirst, State Highway Engineer of Wisconsin, at the Meeting of the American Association of State Highway Officials Held at Omaha, Neb., Dec. 5 to 8.

In considering the design of a modern highway we should not forget that while naturally, we should so design a highway that the traffic can be carried by it just as important as the mere carrying capacity of the road and its ability to resist destruction is that it shall safely and expeditiously handle that traffic.

In other words, the building of a modern highway is the building of a transportation artery and in the design of it we should fully consider all transportation factors involved. The bare factor of getting traffic over the road so that it does not mire in the mud is a small part of the whole. Traffic should be enabled to move comfortably, safely, and rapidly without danger either to itself or to other vehicles using the same roadbed.

We seldom stop to think that there is carried on many of our principal highways more passengers and more tonnage of freight per mile than on many important railroads. Railroads are not content merely to build tracks which will bear the weight of their trains. Railroads are so designed and constructed that trains can move expeditiously and safely, and every precaution is taken to prevent accidents. If it was good public policy to force the railroads to tremendous expenditures for the safety of railroad traffic, I can see no reason why it is not good public policy for the public to protect its own by building really safe highways.

Hazards Best Eliminated When System Is Laid Out.—The first and best chance which a state highway department has of eliminating hazards in highway travel, is in the original layout of the highway system which it expects to build. In laying out the various highway systems toward which we are trending—that is, a federal system, state systems, and county systems, it is possible by careful preliminary work and investigation in establishing the approximate future course of these highways to eliminate a considerable number of the present hazards, without expending anything but brain work in making the eliminations.

In many cases a little investigation of parallel roads will disclose a road potentially free from the objections which can be urged against the old road; in some cases grade-crossings can be eliminated, or the number of right angle turns reduced, or better grades or alignment, or both, can be secured for the final road. It is my opinion that nothing can be more valuable in a territory in which modern highways have not yet been developed, than a careful consideration of every possible route with the idea of eliminating hazards before the road to be constructed is determined upon.

In laying out the Wisconsin State trunk highway system, it was possible for us to eliminate a large number of grade-crossings with railroads, heavy grades, right-angle and other dangerous curves, and other hazards without spending a dollar in construction but simply by selecting routes other than those which had been customarily followed. If we had this work to do over again we would be much more radical in making new routings.

Beauty Also a Factor to Consider.—Another factor which should be considered in the layouts is that of making accessible or visible any feature of the landscape or topography which is extraordinary, beautiful or attractive. Weight given to the selection of routes which are attractive, scenically or artistically, will vary a great deal in accordance with the area traversed and the country served. Those states which are intending to capitalize and encourage tourist traffic should pay a very considerable amount of attention to the factor of having their roads run, wherever possible, where the scenery is attractive or where lakes, rivers, mountains, and forests, can be set out well and made fully accessible. In states or parts of states where these features are not present, there should be the strictest adherence to utilitarian practice in selecting the shortest road which will carry traffic safely and cheaply.

We have found, by sad experience, that any effort to serve two purposes with one road or to compromise on locations is a fatal mistake. Serve those purposes which should first be served with the right road, and if there is not enough mileage to go around, serve the other purposes with the right road later. As well try to make a good bird dog into a good rabbit dog as to try to combine routes in an effort to serve two or more divergent lines of traffic, to the lasting economic disadvantage of all traffic in the vicinity.

Some Fundamentals of Design for Safety.—It is in the design of highway structures that the greatest advancement can be made towards securing both safety and beauty. Up to the present the principal idea of American highway engineers has been to build a structure which would stand up under traffic. Not only has very little attention been paid to the artistic, but in many cases very little attention has been paid to safety. Practice along safety lines is, however, making rapid advances as traffic becomes heavier and faster.

A great many accidents take place at curves, both vertical and horizontal, and it is at these critical points that the greatest advance in the art of highway design can be made. It has recently been stated that more accidents occur on straight highways than on curving and presumably dangerous highways. I doubt if this is true. If so, it is undoubtedly due to one or both of two causes: (a) too narrow surfacing; (b) the presence of more traffic on the straight away stretches than on the sections with excessive curvature. I doubt not that in practically every case if the exact number of vehicles and accidents were known, the road with the most sharp curves would show the most accidents per mile of traffic. A comparison of accidents without a comparison of traffic is worthless.

Vertical curves are almost as dangerous as horizontal curves, especially if the surfaces are narrow and the drivers do not keep to the right side of the road on approaching the crown of hills. Vertical curves should have a radius of at least 1,000 ft. With this radius an approaching vehicle can be seen 200 ft. ahead, and there is comparative safety if there is moderately careful driving.

No horizontal curves of less than 300-ft. radius should be planned unless the circumstances are very exceptional on high speed main lines of travel, and on roads which carry the highest character of traffic almost any expenditure is justified in order to secure such curves or even easier ones. A curve of 300-ft. radius in cut gives vision only 200 ft. ahead and this is little enough when it is considered that two cars going 30 miles an hour will meet in 2 seconds after seeing each other.

Superelevation and Widening Necessary.—Curves should, of course, be superelevated and widened. This practice is now general in the several states, and while in most cases it has not proceeded far enough, more radical superelevations are being used each year. It is our opinion that on curves less than 300 ft. in radius, superelevations up to 1 in. to the foot are desirable. All curves of less than 1,000-ft. radius should be widened, the widening being greater as the radius of the curve becomes smaller. If radii as small as 300 ft. are used, the widening should be to at least 24 ft. on a two-way road.

Where it is impossible to get curves with a radius of 300 ft. or more, if such a case exists, care should be taken to secure at least 200 ft. of vision ahead. Too many engineers are placing their curves so as to restrict the vision, when it is possible by throwing the ends of the tangents away from the bank to put in the same curve and still get vision past the bank. Cutting down banks to the line of vision is being practiced to some extent, but unless good maintenance is secured this is not proving as satisfactory as was expected.

Dead ends come under the same classification as curves. Dead ends are corners where the course of the main highway is not continued by an inferior highway, while the main highway makes a sharp turn. Treatment at such places should be just as radical as at curves, and added protection should be given by erecting white boarding across the dead end so that the driver is notified that the highway turns sharply. On such boards an arrow indicating the direction of the turn is helpful.

We wish to emphasize that the points of danger on our highways occur at curves, and on high-speed, main lines of traffic too much money cannot be spent in securing good vision by building curves of easy radius. The fact that in every case an easier curve shortens the center line distance and thus reduces the amount of paving required, always helps to offset the additional cost of securing right of way for such curves.

Insufficient Width Also a Source of Danger.—After curves, the factor which probably produces the greatest number of accidents is narrow surfacing. It is our opinion that no permanent roadway should be built of a width less than 18 ft. on any main line of travel, and that 20 ft. is a much better and safer width. We do not believe in building over 20 ft. wide unless a road for four lines of traffic is desired, in which case 36 ft. should be the minimum, and 40 ft. would be much better.

It is the writer's opinion that pavements on high speed roads should be some multiple of 10 ft. in width, providing a lane 10 ft. wide for each line of traffic. Such widths as 14, 15, 16, 24 and 32 ft., and any other widths which do not provide a clear width of at least 9 ft. for each line of vehicles sought to be accommodated, are bastard widths and should never be used. Large amounts have been wasted, or partially wasted, in building pavements of such widths. If the traffic does not justify at least 18 ft., a 9 or 10 ft. road should be built so that no one will be deceived into believing that there is a double track road when none, in fact, exists. Such roads can be made double-track roads later when funds become available. We believe also that wide pavements make for easier and cheaper maintenance, in that they keep the traffic off the edges of the pavement (which are always danger points), make for easier shoulder maintenance, and also provide for a moderate distribution of traffic.

Bridges and culverts should be built of adequate widths between endwalls. The distance between endwalls should be at least equal to the width of the top of the fills when new. We suggest that on main lines of travel not less than 26 ft. should be used as the distance between endwalls or parapets of bridges and culverts, and if the grades are wider, greater distance should be provided.

In the design of bridges and culverts, especially in the endwalls and railings, there are great opportunities for the beautification of highways. Artistic paneling or spindles add very materially to the appearance of concrete structures without adding greatly to their cost. We also find that our people are willing to pay for the artistic once they have a sufficient number of samples of artistic bridges from which to judge the effects of good proportions and good designs.

There is room for more artistic development in the construction of guard fences. Nothing, probably, adds more to the appearance of a highway than well constructed guard fence, well aligned and painted white as it should be. It is the consensus of opinion of our engineers that we, in common with most states, have been using more guard fence than was necessary and that part of the money spent could well be saved and, if necessary, used in widening the fills. The use of paint or whitewash on stones to define the edge of fills, where the curvature or height of fill does not necessarily make the place dangerous, is recommended as both cheap and effective. There is so little horse-drawn traffic now that the old purpose of guard fence, to keep horses from jumping off the edges of fills when frightened by automobiles, is almost done away with.

Preserve the Trees.—Every tree which adds any beauty to the landscape should be saved, if possible, and where there are groups of trees offering effective relief it is worth while to make changes in the center line to save these trees, even if additional right of way has to be secured on the other side. A good tree takes many years to grow and can be cut down in a few minutes. Most of us have been wasteful in our destruction of good trees and have not made the exceptions which should have been made in saving trees or groups of trees of distinctive character and merit.

Within the limits of slopes, brush and shrubbery, as well as all other vegetation, have to go. In many cases, however, the clearing and grubbing limits are defined as wider than the slope limits, and thousands of acres of effective shrubbery and flowers have been destroyed which could just as well have been saved. The clearing and grubbing limits should follow the slope line except in the northern states, where snow drifting can be expected. In such cases low-growing brush cannot be encouraged because it promotes snow drifting unless the line of brush is well back from the edge of cuts.

Incident to this point, we probably have not paid enough attention to buying additional right of way where snow drifts occur and planting shrubbery far enough back in the fields so that the snow will not be thrown into the road cuts. It is our opinion that this is the most effective method of keeping the roads open and should be used more generally. The debate between shrubbery and snow fences as means of locating snow drifts, is probably close, but we shall not enter into it here.

We have heard a good deal about tree planting along highways. We are entirely sympathetic with it if it is carried out and followed out by an organization which has some permanency, but the spasmodic trumpet-blowing attempts to plant a few ineffective saplings on certain days and think about them no more, have rather discouraged most of us who really believe in tree planting where the surrounding circumstances permit. There have so far been more "nuts" bearing trees to plant than planted trees bearing nuts.

A good deal of this work has been done without forethought and judgment. If anything really effective is to be done it is the writer's opinion that it must be done by the state highway departments in co-operation with the state forestry departments, and not only must the trees be stuck into the ground but they must be carefully attended until they become old enough to take care of themselves. We will undoubtedly see advances in this direction within the next few years. With good care and judgment exercised in the selection and planting of trees of suitable character there is nothing objectionable about planting trees along highways, and much to be said in favor of it. Even if in some cases a bonus has to be paid to abutting farmers on account of losses due to shading, it is well worth while from the public standpoint, and we believe it is possible to secure such relinquishments from abutting farmers where tree planting is advisable at a very reasonable cost, considering the artistic effects and real benefits to be secured. Even in well timbered states there are sections where a little green on the landscape and and a little shade is very welcome indeed.

The general remarks as to trees apply also to shrubbery. Planted with discretion shrubbery of the right kind and flowers certainly add very much to the general roadside appearance, and are worth money if the beautiful is ever worth money. All of these matters, however, will have to be developed slowly, because a very small fraction of our people are willing to spend any considerable amount of money in highway adornment. The highways are too badly needed, in the opinion of most people, to permit the spending of large funds in beautifying them. A good many feel that they cannot admire landscapes and artistic effects so long as the roads are impassable, and prefer to spend money in building the roads first and develop the beautiful later.

This objection cannot be urged against saving what is already there, and much of this can be saved, not only without additional cost, but actually at less cost because of the lower expenditure for clearing and grubbing. We should not, however, allow beauty to interfere with safety. It is small solace to the injured or to the families of persons killed that accidents occur in and are due to beautiful surroundings. The smell of roses or honeysuckle is small solace in case of real disaster.

Eliminate Grade Crossings.—After curves and narrow surfacing comes the next most prevalent cause of highway accidents—the railway grade crossing. The only safe grade crossing is one which has been eliminated. Many accidents testify that all forms of so-called crossing protection fall down, even flagmen and gates. In planning new main highways every possible effort should be made to secure the elimination of all grade crossings. Each can be done usually in relocating the highways so as to avoid crossing the railways at all. Where two crossings with the same railway line lie within five miles of each other, it will usually be cheaper to buy a new right of way on one side of the track and grade and drain it than to separate the two crossings. If, however, there is something which must be met on the opposite side of the track, such as a village or city which it is necessary to accommodate, this course may not be feasible, although quite usually between the two crossings some point can be found where a separation can be made accommodating traffic to and from the city or village in question, while the main line of traffic is left free.

Each case must be decided upon its merits but both underground and overgrade crossings have disadvantages in alignment, and the best solution in four cases out of five, where the crossings are not too far apart, is to relocate along side the track. Where a highway must cross a railway an overhead is usually superior to an undergrade crossing for several reasons, and is usually less expensive.

Up to recent years about two out of three grade separations built by the railroad have, in reality, been more dangerous to highway traffic than the grade crossings they replaced, because the railroads paid no attention to the matter of highway alignment and in almost every case used crossings perpendicular to their tracks with two sharp and sometimes blind approach curves. Such crossings are seldom, if ever, satisfactory where the highway is in general paralleling the railroad as many main highways naturally do, and when new crossings have to be built the decision almost inevitably falls upon relocating the highway.

Highway intersections, especially intersections of roads built for high speed are another source of grave danger. All intersections should be well signed on both highways and in addition good Ys should be put in in each direction, because such Ys serve to increase the vision for the traffic which crosses perpendicularly, and the traffic which makes the turn fits into line much better if its course is changed as it comes in to its new line of travel.

At many crossings of two supremely important highways it is undoubtedly going to be necessary to separate the grades just as railroads have found it necessary to separate their important crossings. This may sound extreme, but where such cases exist on really important lines of traffic, there can be no doubt that the separation of the two roadways is not only desirable but an economic necessity.

Safety Measures Used During Construction.—Although the safety and the beauty of the highway depend principally upon the design, there are many accidents which are caused by failure to take proper precautions during construction. If a road is to be kept open to travel during construction, the safety and convenience of the traveling public should be the paramount consideration rather than a matter to be almost totally disregarded as is the case in too many instances at the present time.

Roads under construction should either be wholly closed to general traffic, or kept open under conditions which guarantee safe and easy passage. If kept open, grading should be kept closely in hand. On ordinary road work there is no great reason why there should be more than one mile between the completed grading and the first plowing ahead. Contractors would, in most cases, be much ahead if instead of spreading their work over the whole length of the contract and finishing nothing until the last operation, they would keep the grading operation well in hand and finish as they go, starting a slope trimming and finishing crew as soon as the roughing out has proceeded not over a mile.

On many highway jobs the grade lifts are too heavy. Drops of 3 or 4 ft. at the end of a fill are not uncommon. This is contrary to most specifications, makes a poor road, poorly compacted, and besides gravely inconveniences the travel both in going up and down the breast. Even where the cut is not completed or where the fill is not completed, it can be kept reasonably smooth by operating a grader constantly over it as the material is being cut and filled.

The most striking difficulties encountered in keeping roads open during construction are the short detours around culverts and bridges. In the case of bridges, wherever the alignment permits, it is much better to build the bridge on a new site even at the cost of a few hundred dollars additional, and permit the traffic to use the old bridge rather than a temporary structure. In quite a number of cases curves occur near bridges, and it is possible by a new alignment at the point to build a new bridge and maintain the old one during construction.

In the case of culverts, instead of detouring the traffic across the ditches and through fields, which usually are impassable after each rain, we should build the culverts in two sections. While it is slightly more costly to do this, the additional cost is made up many times in savings to the traffic. We have experimented with this method during the last season and our plans and specifications for next year will call for the construction of culverts in two sections wherever we expect to keep the road open for traffic.

In some of the eastern states roads have been built in halves and the traffic dispatched in a single direction by a system of telephoning. We traveled over sections of highway so handled this year, and it was our impression that for a main line of traffic this method was unsatisfactory and that if the money expended in dispatching and in additional cost of construction under such conditions had been spent in temporarily fitting a detour or detours for traffic, the result could not but be more satisfactory, unless there were positively no detour available. Conditions under traffic so carried on Sundays and legal holidays must, indeed, have been serious.

Detours Should Receive Careful Attention.—Where highways under construction are to be absolutely closed careful attention should be given to the detour. If possible, the road over which the detour is to be carried should be given the proper amount of attention the preceding year. Nothing is more exasperating to the motorist than to be detoured along a certain highway and to find it has been recently graded to be ready for the detour and is, itself, as impassable as the highway from which the traffic has been diverted. A little more care and attention given in advance to detours will pay heavy dividends in satisfaction to the traveling public.

Where opportunity exists it is much better to provide a detour for one line of traffic, and to use another highway for traffic going in the opposite direction. If the roads selected for the detours are narrow, this avoids many complications in meeting and many accidents and facilitates the passage of both lines of traffic. Furthermore, the detour roads are not quite so seriously damaged if the traffic is halved. We feel that where there is any question of reasonable doubt the double detour should be used.

Needless to say, detours should be signed and maintained. Signing detours does not mean just pointing an arrow at the first turn away from the road under improvement. It means a consistent series of signs, directing traffic adequately from beginning to end of the detour. There is no more helpless feeling than that which comes to one lost on a supposed detour at midnight, possibly with the rain descending, and all the farmers in the neighborhood gone to bed. If all of our engineers and contractors had been caught in such predicament (as I have been) there would be much greater care used in the selection, maintenance, and signing of detours than is now generally exercised.

A good many present-day highways must be detoured when constructed. It is practically impossible to construct a concrete road without detours. The same is true of almost every road except graveling and grading jobs. But the cost of detouring is a very heavy charge upon the traveling public. Almost invariably the detours are longer than the road under construction, and if the road under construction is a heavily traveled one, the cost to the traffic of making a detour, even one mile longer than the straight road, is very heavy. For instance, a detour three miles longer than the main road, carrying a traffic of 800 vehicles a day, means a daily total of extra travel of 2,400 miles, which even at 10 ct. a mile is $240 per day. If the road under construction is kept closed for 4 months, the cost of detouring will be $28,800, and unless the structure is of such a character as absolutely to preclude taking traffic through, any reasonable expenditure in keeping it open for traffic can be seen to be fully justified.

Whether to detour or not is a matter of especial consideration for each particular set of circumstances. Detours should certainly be kept to the minimum both in number and in length, and where necessarily used should be made as safe as possible and as unmistakable as foresight can make them.

Danger Signs Should Be Used Only Where Danger Actually Exists.—Much can be done to promote safety in highway use by the erection of proper signs at places which are really dangerous. All railroad grade crossings should, of course, be posted. Many States have uniform signs and uniform posting laws. The white circular disc with the two black division lines and the letters "R. R." is now practically standard, and inasmuch as its use is so general it should be made universal. All sharp turns should be signed; also school houses, approaches to principal highway crossings, and all other places where the operator of a car should have it under full control.

The flashing signals on the market are good, but so expensive as to practically prohibit their use, because when such signals are used they should be used universally or else they add to the danger rather than lessen it. When considered from a statewide standpoint the millions of dollars involved put them out of the question for the average State.

Dead ends and very sharp turns which are unavoidably present should be boarded across the end with a white sign board, with an arrow indicating the direction of the turn.

During construction green flags should be used by day and green lights by night to give advance warning of danger ahead. The actual point of danger should be red flagged and red lighted at the point of repair or replacement. A single red light at the structure or place of repair is not sufficient on high speed roads, because often these are mistaken for the rear lights of other motor vehicles and even when not so mistaken the driver sometimes cannot stop before striking the obstruction. There has been too little use of caution signs well in advance of danger and practice in this respect should be improved.

Care should be exercised in erecting signs indicating danger that they are not erected where, in fact, no danger exists, because the constant passing of danger signs where no danger is later apparent makes drivers careless and has the effect of the cry of wolf! wolf! and finally when actual danger is encountered disaster ensues.

Incident to the use of proper guiding and warning signs is the very advisable removal of all advertising signs along highways, especially those which interfere with vision. We are of those who believe that our highways are no place for advertising. Heaven knows there are enough avenues of publicity open to those who wish to sell their goods without making our rural landscapes a futuristic nightmare. The total elimination of such signs is coming very fast and this reform will probably do more to add beauty to our highways than any other single thing. If manufacturers understood that instead of adding to their trade, these signs serve to lessen it, their passing would be only a matter of a very few years, and they can be made to understand this by a proper campaign of education and warning.

The division of roads by center line marking, especially at curves, is a growing practice. There can be urged against it the objections that it serves to concentrate traffic too much, and that it also keeps traffic constantly near the edges of the road slab, thus encouraging corner breaking. I feel that its expediency is very debatable on straight stretches of highway, but that on curves it should be universally used. The possibility of indicating turns, road intersections, and approaching danger on the road surface itself has not been thoroughly worked out, but we feel that there are decided chances of advance along this line. The good driver is always watching the road and can readily note such signs if they can be kept clearly marked.

Proper Maintenance Also Contribute to Safety and Beauty. Something can be done for both safety and beauty by proper maintenance. Signs should be kept clean and repainted as often as necessary. The discreet use of paint and whitewash on guard fences, limiting stones, and signs adds much to the attractiveness of a road. Brush interfering with vision at corners should be kept well cut. The roadside should be kept mowed.

It should not be assumed that just because detour signs have been placed they are going to remain perpetually as placed, because the American small boy and other vandals with less excuse are always with us. Engineers usually go through the work itself and very seldom use the detours, and we have discovered cases where practically all signs were down on detours without the men directly in charge knowing it, because they never used the detour but went through the work. Detours should be in charge of the maintenance department and not the construction department, and the maintenance engineers should be required to travel the detours.

Build safety into the structure by proper design. Do not expect to provide it by large expenditures of paint and signs after blunders are made. Without proper design, maintenance can do little toward providing safety except in cases of disaster to the road structure. Maintenance can, however, assist in beautification by providing well-kept surfaces, shoulders, and ditches, and by keeping all signs and attendant structures well painted or clean. In one way, by keeping shrubbery and trees cut so that they will not interfere with vision, maintenance will add to the safety of the road.

Material Handling on a Federal Aid Job in Iowa

The methods used and results attained in handling materials for the construction of 11.05 miles of concrete road in Palo Alto County, Iowa, are briefly described herewith. The road, which is a Federal Aid project, is located between Emmetsburg and Mallard. The pavement is 18 ft. wide, 8 in. thick at the center and 7 in. at the edges.

Pit run gravel was used in a 1:3.7 mix, which corresponds closely to a 1:2:3½ mix with sand and gravel measured separately. This ratio was determined upon after a careful analysis of the material.

Loading Cars with Barber Greene Loader.

Grading was done in advance by county forces.

The location is on low lands adjacent to the Des Moines River, and at times of high water is partly flooded. The soil is a black loam for the most part underlaid with sand and some sandy gravel. A light industrial railway was installed for the handling of all materials along the road.

Gravel for the work was mined with a drag-line outfit by the county forces at a point 1¾ miles west and 1 mile south of Emmetsburg, which is at the north end of the project. Although the job was let in 1920, a delay in the delivery of equipment limited that year's construction to 2 miles of road south of Emmetsburg. Hauling for the first six miles of pavement was in batch boxes over the industrial track direct from the gravel pit to the paver.

During the winter of 1920-1921 gravel was hauled from the pit at the river to form a stock pile at a point six miles south of Emmetsburg. The gravel was loaded into the batch boxes with a Barber-Greene loader, equipped with a swivel spout, and was unloaded by a small Byer's crane, which raised the batch boxes and dumped them to form a stock pile 250 ft. by 150 ft. by 13 ft. This pile contained approximately 14,000 cu. yd. of material.

Handling Cement at Mixer.

When the 1921 paving season opened the contractors continued to haul gravel from the river stock pile until the midpoint of the job had been passed by the mixer. The loader was then moved to the newly formed stock pile, where tracks and a complete material yard were established, tracks to the river pit were taken up, and the paving operation was continued to the south. Each industrial car carried 44 cu. ft. of material, or enough for 2 batches of concrete. The trains were of 10 cars each. The track was located close beside the finished pavement.

At the stock pile cars were dropped into position by hand, two men doing that work and making the necessary clean-up around the loader. One man operated the loader and one man handled the swivel spout which discharged into the batch boxes. On the average 20 batches were loaded in 20 minutes. The loader was never worked to capacity.

The necessary track moving was done by the loading crew when not busy otherwise and required remarkably little time. These four men with pinch bars moved 100 ft. of track 10 ft. to one side in 10 minutes. As about 2 weeks was required to run the length of the stock pile, track moving was a very small item.

The loader could reach 20 ft. from the toe of the slope of the pile to the center of the batch boxes. Cement was hauled from Emmetsburg by two small trucks with trailers, each truck and trailer carrying about 100 sacks per trip, and averaging about 10 trips per day. This haul of six miles was over the finished section of concrete road, the grades of which were very flat. A small cement storage shed with a capacity of 250 bbl. was built at the side of the pavement at the material yard, and when cement was not being loaded directly from the trucks to the small flat cars on the industrial track it was stored there. Two flat cars with 60 sacks of cement were in each train, the cement ahead of the locomotive and the batches of gravel behind it.

At the mixer the cement was transferred to small flat cars carried on light 24-in. gauge track laid on the subgrade between forms. As the mixer advanced sections of the track were moved forward and the cement on these small cars was always handy and off the ground. The batches of gravel were dumped in the mixer skip by the familiar type of batch transfer. Cement was put into the skip by hand. The mixer was a No. 21E Koehring steam paver with a boom and bucket discharge.

On the long haul of six miles four Whitcomb locomotives were used, making four trips each in a 10-hour day. Each batch contained 6 bags of cement and 22 cu. ft. of gravel, which was sufficient to build 1.83 lin. ft. of pavement. An average of 546 lin. ft. per 10-hr. day was maintained on this job. This required 232 cu. yd. of concrete and averaged 1 batch every 2 minutes and 1 second. The maximum pour in 10 hours was 673 lin. ft., or 285 cu. yd., which means that 1 batch was poured every 1 minute and 38 seconds.

A crew of 21 men handled the loading and hauling of material as follows:

3 cement car unloaders.
2 cement truck drivers.
1 material yard foreman.
1 loader operator.
1 loader spout man.
2 men switching cars and cleaning up.
2 men loading cement at shed.
4 locomotive engineers.
4 locomotive firemen.
1 truckman.
—
21 Total

A crew of 27 men handled the mixing, placing, etc., as follows:

1 steam pump man.
1 man sprinkling.
3 men covering concrete.
1 man finishing edges.
1 machine tamper operator.
2 men spreading concrete.
1 mixer engineer.
1 mixer fireman.
1 batch transfer derrick man.
2 men charging cement.
1 man cutting joints, etc.
2 men handling bags on batch boxes.
2 men on forms.
7 men fine grading.
1 roller man.
—
27 Total

Arkansas Engineers in Public Activities.—The Arkansas Chapter of the American Association of Engineers recently has furthered the organization of the Arkansas Advancement Society, the purposes of which are the promotion of the general interests of the state through the publication of correct information on its affairs, resources, etc. This is one of the first instances in which such work has been undertaken directly by an engineering society.

An Analysis of Present Highway Traffic with Predictions for the Future

By JOHN H. MULLEN,
Chief Engineer, Minnesota Highway Department.

[The highly interesting and informative paper which we give herewith in full, was presented at the meeting of the American Association of State Highway Officials at Omaha, Dec. 5 to 8, 1921.—Editor, Engineering and Contracting.]

The study of highway traffic has been made necessary by the tremendous increase in the use of motor vehicles in this country. Within less than 15 years a complete revolution of highway transportation has taken place, changing within that period from horse-drawn to almost entirely motor-driven traffic.

Horse-Drawn Traffic Still an Element to Be Considered.—On account of the small percentage of horse-drawn vehicles we are now inclined to eliminate them from consideration as a governing factor in traffic studies, but as an obstacle to speed and consequently as a limitation on the volume which may be carried over a congested line this traffic is of importance and calls for thought on the part of highway engineers to provide some relief such as slow traffic lanes along the sides of heavy traffic roads. Most of the road pavements in this country have been built 16 to 18 ft. wide and generally without shoulders adequate to carry a line of slow moving traffic. When one of these roads carrying a small number of horse-drawn vehicles acquires a traffic of over 1,500 vehicles per day there is congestion, decrease of speed and danger of collision on account of difficulty in passing. The decrease in horse-drawn as a percentage of the total traffic has been very rapid, but this does not mean that the volume of horse-drawn traffic has decreased in like proportion. To the contrary, on many main roads it has remained practically constant and in some instances has increased. As a typical example, on one of the main roads in Minnesota the average daily traffic count for the four past years shows the following number of horse-drawn vehicles in successive years 17, 33, 35 and 38 per day, a reasonably constant number, while the same road for the same years showed motor vehicles to the number of 440, 501, 883 and 1,230, respectively. This situation would not exist on roads connecting contiguous industrial centers, but will be found to be fairly general in agricultural communities, particularly where farms are small and horses are required for other farm work. In other words, throughout the United States, horse-drawn traffic will have to be reckoned with as a minor element in highway transportation for many years.

Traffic Increased as a Result of Increased Radius of Commercial and Social Activity.—The remarkable increase in the number of motor vehicles in use in this country, has brought many benefits. As a business proposition, the motor vehicle has increased the trade radius of the merchants, and has made possible dairying and crops requiring quick marketing on great areas of land which could formerly be utilized only for grains and staple crops. It has also made possible the de-centralization of smaller industries formerly confined to restricted districts on account of slow trucking, but which now are enabled to locate in suburban territory. It is predicted that with the improvement of roads this latter condition will be developed to an extent that will greatly improve the living conditions of industrial workers.

The motor vehicle is revolutionizing the social life of the country. Formerly the general travel radius on roads did not exceed 10 miles and the visiting radius in the rural districts was two or three miles. The trip to town was often a weekly affair taking a whole uncomfortable day. Rarely was there any visiting between towns or to different parts of the country excepting on railroad excursions. But with the advent of the motor vehicle the travel radius on highways has been greatly extended and is now limited only to the condition of the roads. We find in the lake regions of Minnesota during the summer, cars from nearly every state in the Union; the census at 137 stations in the State during 1921 showing an average daily traffic of 565 cars of which 59 or more than 10 per cent were from other states. It is reasonable to assume that not less than another 25 per cent were from other counties within the State, which at an average of three people per car meant at least 600 outside visitors per day passing each recording station. Practically every farmer now has an automobile and in the rural districts of the middle west there are farmers' clubs in nearly every township, made possible by their ability to attend evening meetings without discomfort. The trip to town is now a relaxation of an hour or two and the farmer's family makes several drives a week to attend the movies or other diversions in neighboring towns.

One of the greatest benefits is through the consolidation of rural school districts made possible by motor transportation, which is giving to the farm children throughout the country the advantage of graded schools without having to move to the cities. All of this is giving us a broader view of life and creating better general conditions, but at the same time is increasing traffic on the highways, which requires extensive programs of road construction and maintenance.

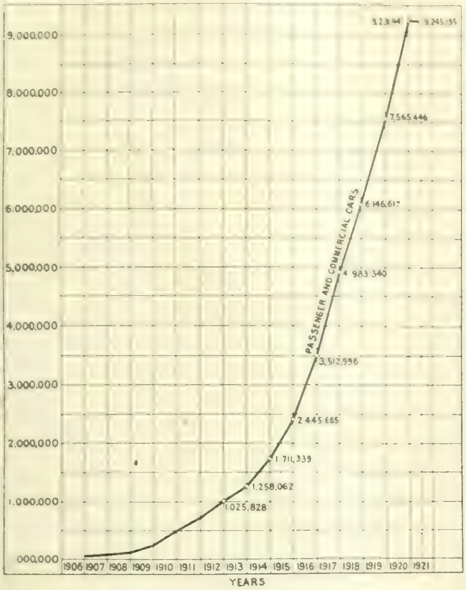


Fig. 1—Motor Car Registration by Years.

Increase in Number of Automobiles Per Capita.—From such records as are obtainable, it appears that the increase in motor traffic is very nearly in the ratio of increase of motor vehicle registration. This increase in the United States, as shown in Fig. 1, follows a rapidly rising curve, starting at 48,000 vehicles in 1906, running to 500,000 in 1910 and 2,445,665 in 1915. From 1915 to 1920 the increase is practically uniform at the rate of about 1,300,000 vehicles per year, with a total registration Jan. 1, 1920, of 7,565,446. During 1920 there was an increase of 1,666,945 vehicles, making a total registration on Jan. 1, 1921, of 9,231,941. Registration for the first six months of 1921, as reported in "Public Roads," is 9,245,195, which would indicate a considerable falling off in the ratio of increase of cars this year. This is to be expected, for it is estimated that the number of cars in proportion to population is approaching a reasonable maximum. In the United States there were 42 persons per car in 1915, 14 per car in 1919, and 11 persons per car in 1920. The 1920 figures range from a maximum of 31 persons per car in one of the southern states, to 5 and 6 in well developed agricultural sections, with 12 to 14 persons per car in the industrial sections where roads are practically all improved. It may safely be predicted that the number of automobiles will not exceed one to five people in the agricultural sections and one to ten people in the industrial sections of the country, even under the most prosperous conditions, with the probability that there may be a falling off in ratio during times of depression, for it must be admitted that prosperity has a considerable bearing upon the number of passenger cars in the country.

Commercial Traffic Presents Most Difficult Problem.—Seasonal variation in traffic as shown by records would indicate that probably 25 to 35 per cent of that on the main lines is regular and may be classed as business or necessary traffic. This traffic will continue to use the existing main lines and would not be diverted by improvement of parallel roads, but the balance, which may be classed as convenience or pleasure traffic will in part seek other routes when the main lines become congested. This leads one to believe that a considerable portion of the traffic will be taken care of by parallel roads, and except for suburban roads and routes physically confined to one line between centers, the volume will not greatly increase on the present heavily traveled roads, but will be spread more uniformly over parallel routes.

Commercial traffic, including trucks and passenger busses, presents the most difficult problem for solution by the highway official. This class of traffic has had a tremendous development within a very few years, but this development cannot be accurately estimated for the reason that many of the States do not have a separate registration for trucks, and traffic counts are scattering and not uniform enough for tabulation. It is estimated that there were approximately 988,000 trucks and commercial cars registered for the year 1920, or slightly over 10 per cent of the total motor vehicles. It is evident from observation and traffic counts that trucks are confined more to cities, and do not use the rural highways in the proportion that pleasure automobiles do except in industrial sections; but it is also very evident that the ratio of increase in the number using the roads is greater than for automobiles. For example, traffic counts taken at the same stations on State roads in Minnesota show daily averages for 1917 of 463 automobiles and 8 trucks, while for 1921 the average is 1,099 automobiles and 72 trucks. Reduced

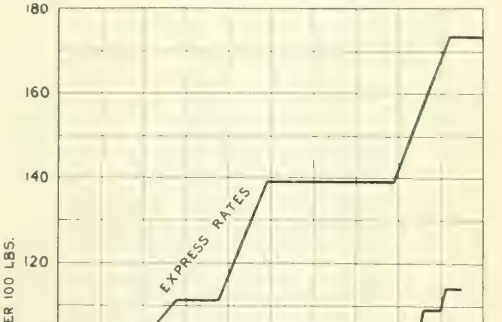


Fig. 2—Express, Auto Truck and Rail Freight Rates.

to percentage the increase in autos is 137 per cent while the increase in trucks is 800 per cent. These figures are taken on roads which were not substantially changed as to surface and the increase is not due to paving or other influence than the development of trucking. Professor Blanchard is authority for the statement that practically the same situation exists in the eastern states, but of course in much greater volume; and cites hard surfaced roads in Rhode Island upon which automobile traffic increased 102 per cent in the past six years while the track traffic increased 659 per cent. The percentage of trucks to total traffic is also comparable in both of these cases, in Minnesota the increase being from 1¾ to 6½ per cent in five years, and in Rhode Island from 3 to 15 per cent in six years. An abstract from the traffic counts made throughout the country indicates that practically the same ratio of increase prevails, and that the ratio of trucks to cars comes within the range of percentages above stated, which is an indication that we should figure the main arterial highways to carry truck traffic in the amount of about 10 per cent of the total, running up to 20 per cent or better on main arteries connecting centers within 50 miles of each other, and not less than 5 per cent on what might be termed passenger trails.

Small Percentage of Heavy Trucks.—Observation on the kinds of truck traffic are interesting, and contrary to the general impression we find that the heavy truck is very much in the minority and with the usual exception of roads connecting neighboring cities, the 5-ton truck does not average more than 10 per cent of the total truck traffic, while 75 per cent of the trucks are 2 tons and less. It is to be expected that truck routes up to 50 miles in length will have an increasing number of 5-ton or larger trucks, but up to the present time and in the near future the bulk of the trunk traffic is what may be termed express rather than freight and can be hauled more economically in the lighter trucks. Furthermore, one of the considerations in selecting truck service in preference to railroad service is speed and the convenience in the pick up and distribution of loads, which are points in favor of the lighter truck. A bulletin was recently issued by the Department of Agriculture dealing with motor trucks on farms, in which it is stated that on a survey of 753 farms in the eastern states it is found that the farmers own trucks of all sizes ranging from ½ to 5-ton capacity, but that nearly half of the trucks used on farms are of the 1-ton size with only 3 per cent of the owners recommending trucks of over 2-ton capacity. The same condition is found to exist in the middle west where farmers at a considerable distance from railroad stations are using trucks quite extensively and in practically all cases are selecting 2-ton trucks or smaller on pneumatic tires. The extent to which this traffic may grow is dependent almost entirely upon the improvement and systematic maintenance of roads, for a steady traffic of 20 trucks per day regardless of weather conditions, is more injurious to an earth or gravel road than automobile traffic averaging 300 cars per day.

Commercial Trucking—Profitable and Unprofitable.—Commercial trucking of commodities outside of cities has developed somewhat blindly and it is found that this service has not been generally profitable to the truck owner except where the entire length of the route traversed is hard surfaced. As an example, a terminal truck service was established three years ago at the Twin Cities in Minnesota and in the second year 25 companies were operating through this agency over all kinds of roads. Of this number, seven have discontinued business on account of poor sections of road on their routes, the remaining 18 companies are continuing to do business in a more or less profitable way dependent upon the proportion of good roads on the lines they cover. This service has been conducted practically the same as railroad service with regular tariff sheets for the various lines and with cargo insurance in all cases. An attempt was made to operate trucks on a time schedule but this was found practically impossible on account of weather conditions and unfinished sections of road which prevented hauling at certain times. The interesting feature to engineers in analyzing this service is that the trucking companies find 2 and 3-ton units on pneumatic tires to be the economical size.

Truck Charges Compared with Railway Freight and Express Rate.—Fig. 2, a chart of the rates as compared with first-class freight rates for less than carload lots and first-class express rates, shows that the auto transportation rates while about 100 per cent above the freight rate, is only 50 per cent of the express on the short haul, but for the longer haul the ratio of difference between freight and auto increases and between auto and express decreases, showing that the unrestricted use of public highways for commercial trucking works very much to the disadvantage of railroad express business for distances up to about 100 miles. For short-haul freight, when taking into account the terminal trucking, the auto transportation will relieve the railroads of what they have always claimed to be an unprofitable business and this at a decreased cost to the public. In this connection it is interesting to note the reported statement of officials of a railroad company in New England that the railroad loses $1,000,000 a year in freight revenues on the shoe industry alone as a direct result of motor truck competition and that some of the small branch lines in the industrial sections of New England have been abandoned by reason of their inability to meet motor truck competition.

Motor Bus Service.—So far as traffic is concerned motor bus service may be included as trucking, for most of the busses are 1½ and 2-ton high speed trucks. This bus service is becoming quite general throughout the country and is conducted profitably during favorable weather at rates slightly less than railroad passenger rates. We find, however, that there is a decided falling off in the motor passenger business during bad weather and in winter. Continuous bus service is only established on long sections of surfaced roads, and with the paving or even gravelling of connecting lines of travel we may expect a substantial development of this traffic with its consequent effect upon the railroad passenger business.

It is very evident that in fairness to the tax-paying public and the railroads, there must be a State supervision of commercial use of the highways, and that taxes on gross earnings should be imposed for this privilege, or at least that more equitable motor vehicle taxes be fixed for such use of the roads with all revenue made available for road purposes. It is only reasonable that commercial traffic should carry its share of road expense and that the State should prohibit the commercial hauling of passenger or commodities on public highways except by responsible concerns bonded and supervised by the State.

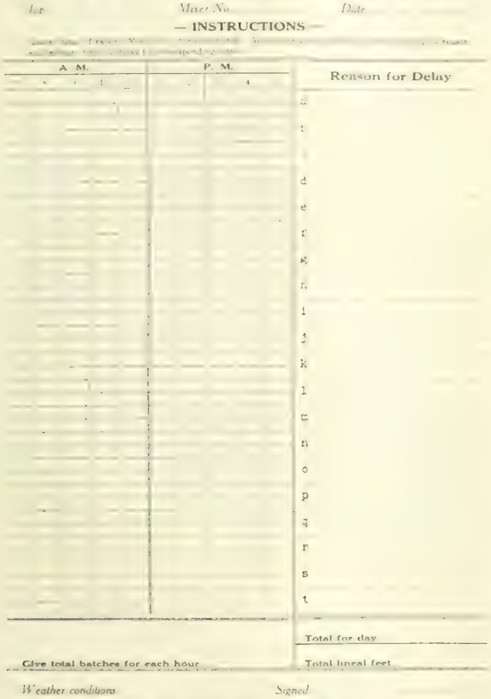
Study and Regulation of Speed.—As stated with reference to horse-drawn traffic, the volume which a given road may carry is governed very largely by the manner in which traffic is handled. Practically all State laws now prescribe a maximum speed limit of 25 miles per hour with no reference to minimum speed. To properly handle traffic the maximum on heavy passenger lines should be increased to 40 miles per hour for certain hours of the day with a requirement that traffic must stop on the intersecting lines before crossing or entering the main line, and there should be a minimum speed limit on main lines of 25 miles per hour during these hours. It will be found that roads which now appear to be congested will very easily handle their traffic within these limits, and there is no reason why the minimum rate of speed should not be imposed for at least a 12-hour period from about 8 in the morning until the same hour in the evening. This will take care of the peak load of passenger and light express business and will cause the slow, heavy trucking to be handled during the night when there will not be interference on either side. This and other effective traffic regulation calls for a State system of traffic police, the value and efficiency of which has been well demonstrated in the State of Pennsylvania.

Study and Regulation of Weight.—Highway engineers and most truck manufacturers are practically agreed upon an economical limit of weight of vehicles and wheel loads for public highways. This is expressed in the proposed uniform traffic law adopted by the American Association of State Highway Officials and which has been incorporated in the highway laws of several of the States, but in all localities we find an occasional trucking company or truck manufacturer using excessively heavy vehicles. If this were allowed to continue the public would be called upon for an unwarranted expense to rebuild roads destroyed by that small portion of traffic and it is therefore extremely important that a uniform limit be established throughout all of the States, and this limit should be well within the maximum prescribed in the proposed traffic law.

Importance of Studies by State and National Departments. – In making a study of highway traffic one is impressed by the lack of definite comprehensive information on the subject and the conclusion is that in every highway department there should be an engineer assigned to traffic surveys. These surveys should be made in a somewhat uniform manner in all of the States and the results compiled for the whole country by the Bureau of Public Roads. The highway departments are not organized primarily for the purpose of moving dirt and building pavements, but in performing their real function in the development of the country they are in fact great traffic departments designed to provide means of carrying the tremendous volume of highway transportation, and to properly do this work the systematic study of highway traffic is essential.

Blank for Keeping Tab on Paver Operations

A form that is being used widely in the south by contractors for reports on operations of their mixers in road work is illustrated below. On the paving time the contractor is not able always to be on the job and he must rely on the reports that come into his office. He sees that about 50 per cent of the time he is getting the expected amount of work completed and that for the rest of the time he gets 30, 50, 60 or 80 per cent of the expected work. He asks why, and various excuses are given. He is unable to correct the trouble because he must deal with excuses and guesses. If he really knew the reasons for the delay he could fill up the gaps, patch the weak spots and so [illegible] get nearer the expected amount of work. This form gives definite reasons for delays. A boy is hired and he stays at the mixer all day. The boy records the time of raising the skip for each batch, and the contractor can tell just how often a batch went through the mixer. If between one batch and another 5 minutes has elapsed there is something wrong—there is a delay that should not have occurred. The boy puts down the reason for the delay. The next morning the contractor has this detailed report on his desk. He can quickly analyze it, and by comparing reports day from day he can improve his equipment and his organization. The form was prepared by Burton Franklin, Chattanooga, Tenn., southern distributor for the Multi Foote Pavers.



Lot *Mixer No* *Date*

— INSTRUCTIONS —

A. M. P. M. Reason for Delay

Total for day

Give total batches for each hour Total lineal feet

Weather conditions *Signed*

Form for Keeping Daily Records of Paver Operations.

Features of the New Minnesota Road Law and Work Done Under It

The Minnesota road law, passed by popular vote on submission by the legislature of 1919 and effective since the spring of 1921, is reported as proving so highly satisfactory that we furnish an outline of it herewith and also some condensed information on recent operations of the Minnesota Highway Department.

The road law referred to, known as Good Roads Amendment No. 1, provides: First, for the establishment of a system of trunk highways to be constructed, improved and maintained forever by the state. Specified routes approximating 7,000 miles are to connect county seats and important towns in all sections and also the lake and other recreational regions. Additions are permitted upon completion of 75 per cent of the mileage.

Secondly, the state trunk highway fund is created to finance trunk system operations. It includes federal aid allotments and the proceeds of a higher tax on motor vehicles using the highways, in lieu of personal property and other levies except city wheelage taxes. A further provision is for the authorization of trunk highway bond issues to run not to exceed 20 years and to limit to $75,000,000 the amount that might be lawfully outstanding at any one time.

To insure against cessation of work by counties on the trunk routes in anticipation of adoption of Amendment No. 1, the legislature of 1919 also authorized counties, under certain restrictions, to issue up to $250,000 each of bonds, proceeds to be expended on the trunk highways, and virtually pledged reimbursement by the state. Many counties acted under the law.

The motor vehicle tax schedules are based upon factory list prices with depreciation allowances of 25 per cent for 3 and 4-year-old machines, and 50 per cent on cars 5 years old or older. The passenger car rate is 2 per cent with a $12 minimum, and the truck rate 2¼ per cent, $15 minimum. The average was estimated at less than $20 a year. Dealers are assessed $25 a year for licenses, and are charged nominal fees for extra license plates for cars which can be used lawfully only for actual demonstration purposes. Dealers in used cars must pay regular rates on cars remaining in their possession after Nov. 1. Taxes for the last six months each year are at half rates. Penalties attached for delayed payments. Motor vehicle taxes are collected and license plates issued by the secretary of state. General highway statutes were completely recodified to corelate new sections with those affecting the local highway authorities.

This scheme was worked out by Mr. Charles M. Babcock, highway commissioner, and is generally known as "The Babcock Plan." In its promotion, Mr. Babcock used among others the following arguments:

"Let wheels using the highways pay a fair share of road improvement and upkeep expense. Put a heavier tax (the average was $10.60 a year, including the license fee of $5 for three years) on each automobile and truck and use the proceeds to build up and maintain the trunk highways. Good roads will enable car owners to save more than the tax on repairs, tires, gasoline."

"Use the motor vehicle tax revenue and federal highway aid on the trunk roads. . . . Leave the counties and towns all local tax funds and state highway aid for the secondary or feeder roads. Without the expense imposed by the main highways, they will be able to adequately improve and maintain the feeders. It is primarily a farm-to-market roads plan."

Prior to the passage of the amendment there was a combination of insufficient funds for highway maintenance and construction with an opposition to any further tax levies for road purposes.

The new law was favored, and its enactment secured through the efforts of many individuals and organizations throughout the state, the campaign being directed by the Minnesota Highway Improvement Association, a semi-public corporation formed by state officials and good road advocates from private life.

On entering its greatly enlarged field of operations the highway department correspondingly increased its administrative force. County road engineers, familiar with local conditions in various sections, were added to the staff, filling the positions of eight division engineers and sixteen district maintenance superintendents.

The first efforts of the department were toward the maintenance of the entire trunk system of the state in good, passable condition. This was done in general accordance with a plan worked out several years previously by the late George E. Cooley and Mr. John H. Mullen, present chief engineer. This plan called for the extension of early benefits to every locality in the state by providing a constant-duty patrolman or road-mender for each 5-mile section of the trunk highway system. Every patrolman must live on or near his "beat" and furnish his own team or tractor, grader, drags and other tools. The going wage is paid the patrolmen and they receive an allowance for rental of equipment, the latter method being adopted to insure better care of tools.

According to official records more than 1,200 patrolmen were covering about 6,200 miles out of the 7,000-mile system within sixty days, from the signing of the bill by the governor. In some cases the patrolmen worked to disadvantage at the start because of poor foundations, and state fleets of heavy outfits were used to help them.

Fleets were made up of 50 tractors and 150 trucks, part of the surplus war equipment turned over by the federal bureau of public roads. The trucks were overhauled and fitted with hoist bodies for handling gravel in machine shops maintained by the highway department on the state fair grounds.

New construction was undertaken at the earliest possible date, and paving contracts were let at rates as low as $28,300 per mile. On July 15, 1921, about 70 projects totalling more than $5,000,000 were under way in different parts of the state Lack of anticipated federal aid and the failure of the state legislature to authorize any issues of trunk highway bonds enforced a curtailment of the first season's program. A measure of relief, came through reimbursement bonds which had been voted by certain of the counties, but county officials as a rule apparently felt that the state would maintain the trunk routes, and therefore insisted that bond money be used for hard surfacing.

Approximately $7,500,000 of reimbursement bond money was used and some counties gained precedence in local improvements on the system. Motor vehicle tax revenues reached about to the $6,000,000 expected, and with the reimbursement bond money, the trunk funds aggregated $13,500,000. Federal aid later added $2,123,000 to the trunk fund. Counties and towns were furnished more than $12.500,000 for exclusive use on the secondary highway system—about $11,000,000 from local tax revenues and $1,650,000 from state aid.

When the trunk highway system was transferred to the state it was listed with 1,499 miles graded, 1,371 miles graveled and 112 miles paved, the balance being for the most part good dirt roads. To these there were added during the first 6 months' operation of the new law, 103 miles of hard surfacing, 438 miles of graveled surface, and 680 miles of grading. In addition, the maintenance forces reshaped 713 miles of surface and regraveled 462 miles.

The expenditures approximated $4,758,026 for grading, $1,605,122 for graveling, $3,549,259 for paving, and $514,047 for bridges, and with the $3,000,000 set aside for maintenance, made the regular season total of $13,426,454 on trunk routes and exclusive of betterments on the secondary road system.

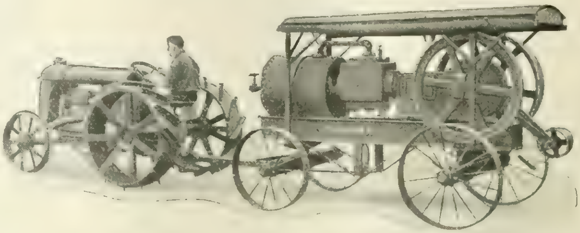
About $4,500,000 winter work has been undertaken, with the intention that it should not only expedite the road program but should also afford a measure of relief to the unemployment situation.

Bids early in December on 44 widely distributed projects estimated at $2,293,500 and covering more than 300 miles were called for within ten days after congress voted federal aid. The state attorney general has ruled that the collection of vehicle taxes may lawfully be anticipated to match the federal aid. Steam shovel excavation and the distribution of materials constitutes the larger part of the winter work.

End of Toll Gates on Main Roads of Pennsylvania. An agreement was approved on Dec 12 by Highway Commissioner Lewis S. Sadler of Pennsylvania for the acquisition by the State of the Dublin and Souderton Turnpike.

New Portable Air Compressor Rig Belt Driven from Tractor

A portable air compressor unit designed for operation by a tractor has been brought out by the Sullivan Machinery Co., Chicago, Ill. The rig consists of a horizontal single stage splash oiled belt driven compressor, standard in character, except for the fact that a hopper or open jacket for cooling water is substituted for the closed jacket in order to eliminate the circulating pump. This rig is mounted, as shown by the illustration, on a steel truck, together with the air receiver and connecting piping, and the whole is protected from the weather by a canopy top with curtains. The tractor performs the service of hauling the compressor from place to place and when air power is desired for drilling or for other work the rig is turned around, and a pulley on the tractor engine serves to drive the compressor through the belt.



Portable Tractor Operated Air Compressor Unit.

Cost of Industrial Railway Haulage on Texas Road Job

The following data on industrial railway haulage in concrete road construction are taken from the December Bulletin of the Associated Pennsylvania Highway Contractors. The haulage was for the Iowa Park-Electric concrete road in Wichita County, Texas. Potts & Prentice were the contractors.

Width of pavement, ft.		18
Average thickness, in.		8
Total pavement placed in April, 1921	Reinforced with wire mesh	Not reinforced
	26,076 sq. yd. 13,038 lin. ft.	12,600 sq. yd. 6,300 lin. ft.
	Total pavement	38,676 sq. yd. 19,338 lin. ft.
Working days		21½
Maximum lin. ft. days run (both mixers)		1,033

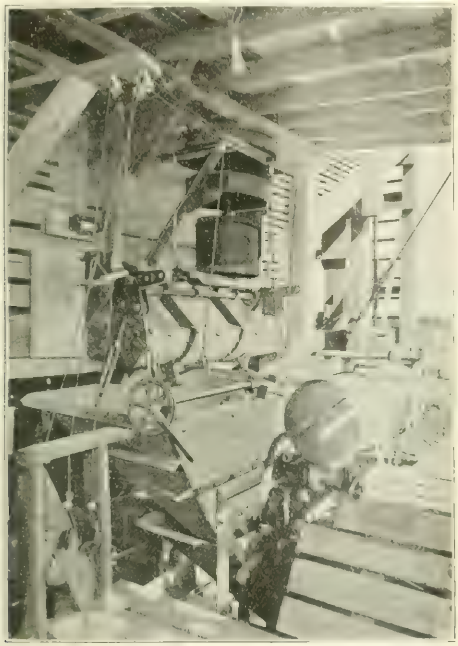
Tonnage handled per train:	Gross.	Tare.	Net (Con. matl.).
Cars—10 at 1,000 lb.	......	10,000	......
Batch boxes—20 at 450 lb.	......	9,000	......
Stone—270 ft. at 105 lb.	......	......	28,350
Sand—160 ft. at 110 lb.	......	......	17,600
Cement—70 sack at 96 lb.	......	......	6,720
	71,680 lb. 35.84 ton	19,000 lb. 9.5 ton	52,680 lb. 26.34 ton

Average haul (miles)	2
Grades against loaded train, east mixer	None
Grades against loaded train, west mixer	0.8% (max.)
Average number of trains per day	31
Maximum number of trains per day	36
Number of trains operated per day	5
Ave. net tonnage concrete material hauled per day	816.5
Ave. gross tonnage handled per day	1,111.0
Maximum net tonnage handled per day	948.21
Maximum gross tonnage handled per day	1,290.21
Average net ton miles per day	1,633

Cost of operation, average day:				
5 locomotive drivers, at	$7.50	$37.50		
3 hours master mechanic	1.25	3.75		
75 gal. gas, at	.18	13.50		
3 gal. oil, at	.70	2.10	(1.75)	$56.85
Track gang, maintenance, moving track and switches from east to west mixer:				
10 trackmen, at	.40	20.00		
1 foreman	7.50	7.50		27.50
Total operating cost				$84.35

New Device for Accurately and Uniformly Proportioning Batches

A device for more accurately measuring concrete aggregates into batches, is one of the newest developments in construction equipment. Two of the new machines are already in use by the Parklap Construction Co. on the Sherman Island Hydro-Electric development on the Hudson River for the International Paper Co. One of them is shown in the illustration. This machine proportions by measuring the aggregates by weight instead of volume. Only one man is required to operate the mixer and the proportioner. The proportioner is a steel panel of ¼ in. plate so constructed that it can be framed into any standard bin. At the bottom of the panel are three openings fitted with bin gates. A center gate 18x12 in. is for stone. The 12x12 in. gates at each side are for sand and cement.



Lakewood-Johnson Proportioner.

A shaft extending the width of the plate is supported by double ball bearings mounted in dust proof split brackets. On this shaft are three cams, one operating each gate. These cams are adjustable so that they may trip their respective latches when the proper balance is obtained. Keyed to this shaft and mounted in the split brackets are bell cranks, forming the scale beams. To the upper ends are attached cables running over pulleys to the counterpoises. From the lower ends is hung an auxiliary hopper discharging into the batch hopper of the mixer. The bell cranks being keyed to the shaft and connected together through an endless cable at the upper point of the crank, act as a unit. The top channel, with its braces extending outward from the channel face, supports the guide for the counterpoises and the pulleys for the cable. Two of the counterpoises are normally seated on these angle braces while the third rests on the channel cradled in the cable. By means of ropes leading from eye bolts fastened to the gates up through pulleys supported in the top brace, thence to one side of the panel and thence to the operator, the latter is able, from one position, to open the various gates and operate the proportioner.

Three pans of sufficient size to take care of the counterweight necessary for weighing the sand, stone and cement, ride on a vertical shaft. The bottom pan is for stone, the middle pan for cement and the top for sand. The ratio between the weight in the pans and the weight of the material in the auxiliary hopper is one to five. Therefore, if it is desired to use 1,000 lb. of stone in the batch, a counterweight of 200 lb. is placed in the stone pan. Similarly, the weights of the upper two pans may be adjusted to give the correct weights of cement and sand desired.

To measure a batch the stone gate is opened and as the weight of the stone in the auxiliary hopper balances the weight in the bottom pan, the pan rises and a cam on the horizontal shaft automatically closes the gate on the stone bin. The cement gate is then opened. When the combined weight of the stone and cement in the auxiliary hopper balances the weight of the two lower pans, the pans rise and a second cam closes the gate. The same cycle takes place in operating the sand gate except that the weight of the material in the auxiliary hopper must counterbalance the weight of the material in all three pans. The batch is then complete and is dumped into the mixer. As the material leaves the auxiliary hopper the pans automatically drop to their original positions and the proportioner is then ready for another batch.

It is stated that materials can be measured so accurately with the proportioner that the error per 1-yd. batch will rarely exceed 50 lb. It is not necessary to have a skilled operator to secure accurate measurements on the job with this device.

The machine described above is known as the Lakewood-Johnson Proportioner. It is manufactured by the Lakewood Engineering Co. of Cleveland, under the patents of Nathan C. Johnson, of the firm of Hool & Johnson, Consulting Engineers, New York City.

Cost of Brick Pavement at Washington, N. C.

The city of Washington, N. C., has just completed 80,000 sq. yd. of vitrified brick pavement using plain wire-cut brick without lugs, 8½ in. x 4 in. x 3 in. The brick were laid flat providing a surface thickness of 3 in. Asphalt filler, heated to 425° F., was applied. It was of the consistency of heavy oil, and it readily flowed into the joints of the brick, which were laid tight. A squeegee of the same design as is used for cement grout filler was used.

The following cost table was compiled on a portion of the work by City Engineer, P. C. Painter:

COST OF SURFACE

	Per sq. yd.
Vit. brick, including hauling	$1.1[illegible]
Laying and rolling	.657
Asphalt filler, 1.65 gal. at 10c	.165
Applying filler	.018
Sand covering	.001
1 in. cement-sand cushion (1:4)	.144
Foreman	.012
	$2.120
Overhead 5%, contingencies 5%	.212
Total cost surface per sq. yd.	$2.332

4 IN. CONCRETE BASE (1:3:6).

Mixing with central mixing plant	$0.0247
Materials	.7423
Foreman and labor	.0104
Hauling ½ mile in trucks	.0530
Fine grade	.0107
	$0.8411
Overhead 5%, contingencies 5%	.0841
Total cost base per sq. yd.	$0.9252
Total cost wearing surface and base per sq. yd.	$3.2572

The foregoing data are based on the following prices, f.o.b. cars or barge, Washington, N. C.: Brick, $31.75 per M.; sand, 75 ct. per cubic yard; gravel, $2.65 per ton; cement, $2.79 per barrel net; asphalt, $30 per ton. Labor, including pavers, was paid 20 ct. per hour. Trucks were Fords with dump bodies and cost $1 per hour.

State Highway Construction in Pennsylvania.—The annual report of the State Highway Department of Pennsylvania covering the years 1917, 1918, 1919 and 1920, which has been in the hands of the state printer for some time, shows that during those four years Pennsylvania built a total of 720 miles of roadway of a durable type. Of this mileage 666.65 miles were constructed during 1919 and 1920. The construction by types follows:

Type	1917.	1918.	1919.	1920.	Total
Reinforced concrete	6.64	28.18	175.37	326.78	536.97
Brick	.81	8.87	20.24	17.42	47.34
Bituminous surface		2.44	23.72	47.44	73.60
Sheet asphalt		2.16	30.42	20.37	52.95
W. B. macadam	.66	1.29	3.03	1.87	6.85
Grading and drainage	.39	3.03	.32	.....	3.74
Total	8.50	45.97	253.10	413.88	722.45

Principles of Business Letter Writing

Some excellent suggestions on the above subject are given by Mr. T. H. Bailey Whipple of the Westinghouse Electric & Manufacturing Co., in a pamphlet, from which we quote the following:

Making a Start.—"Unless one is experienced and very gifted, all letters of unusual importance should be either blocked out or completely written by hand.

The dictation of letters has its advantages, but it has some disadvantages also. It is a real accomplishment to be able to readily marshal one's forces of thought and expression so as to dictate without undue hesitation a letter of real force and elegant expression. Few, however, have this rare power."

A letter written by hand co-ordinates nervous force with muscular action. The very act of picking up a pen and getting into motion stimulates nervous activity and excites the play of thought and imagination. We are so constituted that but few realize the very close, intimate and essential relationship between our physiological and psychological natures.

A literary or scientific writer usually has the advantage over the business writer. When one picks up a literary or scientific book he is seeking amusement, entertainment or instruction. He is receptive and usually interested. When we receive a business letter we are quite often interested in neither the writer nor the subject. Because direct-by-mail sales solicitation has become so voluminous and importunate, we often find ourselves in a mood of antagonism when we find our mail flooded with letters of this character. The difference between business and other literature is analogous to the difference between negotiating sales to one who steps into your place to buy and that of a traveling salesman, who, unsolicited, approaches the buyer.

The business letter, must, therefore, have the force of pleasing personality in order to meet with a cordial reception. It must quickly attract favorable attention. It must hold and augment attention to the point of live interest. It must weld interest to desire and force desire into conviction and action. Often, like many plans of salesmanship, investigation and preparation must precede the approach. Many sales are practically made before formal negotiations begin.

The general characteristics of good business letters are: Clearness, Conciseness, Completeness, Correctness, Courtesy.

To embody these elements in letters, all characterized by vitality and force, it should be our aim to cultivate: Originality, Imagination, Sympathy.

Clearness.—The most essential quality in any letter, and especially in any business letter, is clearness. This fact should be obvious.

Granting the reader to possess ordinary comprehension and education, it devolves upon the writer to make his message readily understandable. To accomplish this end straight thinking is necessary to avoid possible ambiguity or uncertainty. Usually, conciseness is an accomplishment of clearness, but even verbosity is preferable to any obscurity of meaning.

The reader may tolerate the boredom of wordiness; he may ask for further information to complete the understanding of the subject in its entirety; he may pardon your illiteracy and generously forgive your discourtesy, but if you have not made yourself clear as to what you have written, his disappointment reaches the climax and makes the desired reaction to your message impossible.

Conciseness.—Conciseness of thought and expression may be, to some extent, an inherent trait, but is almost always the result of care and real study to this end. Clear thinking and a careful choice of words are the only means to acquire this force of composition.

Brevity, of itself, is not the chief purpose of conciseness. Compressed meaning is more essential than mere condensed words. Brevity may carry with it incompleteness, unless the thought is expressed in words that are comprehensive in themselves; words that are pregnant with exact meaning; suggestive as well as explanatory; incisive, going to the heart of the subject in a straight line of thought as well as of words.

Completeness.—Incompleteness causes irritation and inconvenience and involves the loss of time and necessitates duplicated effort to get results. Even when the result is not fatal to success, the impression created by omissions in the written orders, or in the necessary explanations of conditions in the written orders, or in the necessary explanations of conditions upon the mutual agreement between seller and buyer is based, is often difficult to overcome, and may seriously affect future relations.

Correctness.—Company pride, if nothing else, should cause the correspondent to aim for correctness in punctuation, spelling, grammar and sentence construction. The same reason necessitates care in all that relates to the mechanical appearance of the letter, such as stationery, typing and paragraphing.

Courtesy.—In treating of courtesy let us recall the true purpose underlying all business correspondence, viz: to establish and to maintain relations between the seller and buyer that yield profit to the one and satisfaction to the other.

Courtesy means the making of every effort to smooth friendly intercourse. It avoids giving offense, and is blind, as long as possible, to the personal offenses of others. But it never allows a real offense to pass unchallenged, even though it makes the challenge as tactful as possible.

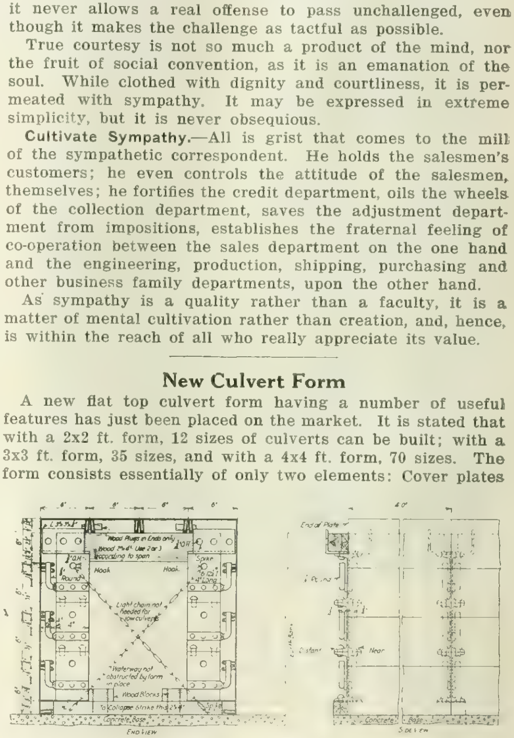
True courtesy is not so much a product of the mind, nor the fruit of social convention, as it is an emanation of the soul. While clothed with dignity and courtliness, it is permeated with sympathy. It may be expressed in extreme simplicity, but it is never obsequious.

Cultivate Sympathy.—All is grist that comes to the mill of the sympathetic correspondent. He holds the salesmen's customers; he even controls the attitude of the salesmen, themselves; he fortifies the credit department, oils the wheels of the collection department, saves the adjustment department from impositions, establishes the fraternal feeling of co-operation between the sales department on the one hand and the engineering, production, shipping, purchasing and other business family departments, upon the other hand.

As sympathy is a quality rather than a faculty, it is a matter of mental cultivation rather than creation, and, hence, is within the reach of all who really appreciate its value.

New Culvert Form

A new flat top culvert form having a number of useful features has just been placed on the market. It is stated that with a 2x2 ft. form, 12 sizes of culverts can be built; with a 3x3 ft. form, 35 sizes, and with a 4x4 ft. form, 70 sizes. The form consists essentially of only two elements: Cover plates and center sections. All cover plates are 4 ft. long and are made of 14 gauge (5/64 in. thick) hot-rolled blue annealed steel. The side and top plates are 6 in. wide after being flanged 1¾ in. along each edge for stiffness. Each flange is of double thickness and strength. All side and top cover plates are alike, symmetrical and interchangeable to any size form. The center sections are standard 6 in. 12¼ lb. I-beams 4 in. long. Holes are punched in the upper, and rivets welded in the lower flanges of these beams. When the beams are stacked upon one another lateral movement is prevented by the rivets fitting into the holes of the beam below. Onto each side of the web of these beams is riveted a hook that fits through the holes in the flanges of the cover plates. The length of these hooks bears such relation to the thickness of the 2x4 between the lower section and the concrete base, that when the 2x4 is driven out all center sections immediately drop, bringing the hooks out of the holes and thereby releasing all cover plates. The hooks are made of ⅝ in. rounds.


6"
6"
6"
6"
4'0"
Wood Plugs in Ends only
Wood 2"x4". Use 2 or 3 according to span
Spike
Round
Hook
Hook
4" Long
Light chain not needed for low culverts
Waterway not obstructed by form in place
Wood Blocks
To Collapse Strike this 2x4
Concrete Base
End View
End of Plate
Near
Concrete Base
Side View

Details of Bilger Culvert Form.

The form was designed by H. E. Bilger, formerly Road Engineer of the Illinois State Highway Department. It is manufactured by the Highway Culvert Form Co., 5460 Ferdinand St., Chicago, Ill.

Snow Removal with Light Road Machine

Reports have been received from 2 Kansas municipalities telling of successful snow removal with the "Road Razer," a one man light gasoline machine made by the Avery Company for shaving and smoothing dirt and gravel roads, spreading gravel, etc.

Slightly different methods have been followed in Salina following a recent snow storm. Mr. Ed. Buchanan, street commissioner, writes that this is the best means he has so far found for removing snow, the work being accomplished speedily and so thoroughly that the streets dry in a short time.

A similar satisfactory account comes from Great Bend, with an additional comment that some of the snow was packed and frozen into ice. It is stated that a lengthening of the arms on the rear blade by about a foot helps the work, but that because of the time necessary for the adjustment the machine is often used without it.

Slightly different methods have been followed in Saline and Great Bend. In the former place, as shown in the picture the snow is moved from the center to the sides of the street; while in the latter when snow is heavy, the machine is first sent along the curb, clearing out the gutter and piling the snow in a ridge about 6 ft. out in the street. Subsequent handling depends upon whether the street is wide or narrow.

"Road-Razer" Clearing Snow at Salina, Kan.

Device for Testing Smoothness of Bituminous Pavements

Exceptional smoothness making for easy-riding quality on new paving on the Minnesota trunk highway system is attributed by John H. Mullen, deputy commissioner and chief engineer of the Minnesota State Highway Department, to the use of a straight-edge on asphaltic tops and the use on concrete pavement of what is locally called a transverse strike board.

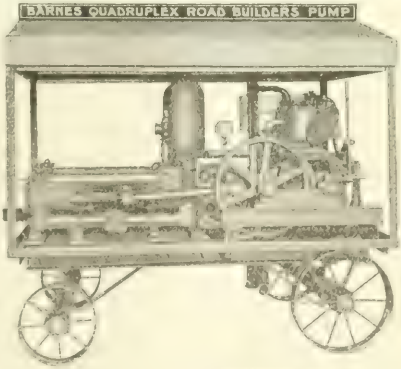
The accompanying illustration shows the straight-edge, which was developed by H. G. Overholt, an inspector of the State Highway Department. The device is made from a 2 in. by 4 in. timber. On the top at the middle is a carefully balanced indicator hinged on a fulcrum with one arm four times the length of the other. Attached to the shorter arm is a weighted pin which extends through a perforation in the timber and rests on the pavement surface when in use. The pin has free play. At the opposite end of the indicator is another pin driven into the timber but not attached to the indicator. When the straight-edge rests evenly on a flat surface, the indicator points to the head of the stationery pin. When the straight-edge is pushed over an uneven area, the playing pin raises or drops and the bulge or depression is indicated. When more than ¼ in. variation in the 10 ft. span is shown, the area is rolled again.

On straight concrete pavement where the straight-edge is not adapted, the Minnesota department is using a straight board with rounded edges. This discloses any unevenness when drawn over the soft concrete.

Straight-edge Used to Ensure Smooth Surface on Asphaltic Top Pavements.

New Heavy Duty Pumping Outfit for Road Building

A portable pumping outfit designed especially for continuous heavy duty service in road construction has been developed by the Barnes Manufacturing Co., Mansfield, O. The initial one of these units installed on a road job is stated to have supplied all the water necessary, for the 21E paving mixer and for curing the concrete, through 21,000 ft. of 2 in. pipe and against a head of 310 ft. Under these conditions the pump operated at 490 lb., often 24 hours per day as during the extremely hot days of last summer it was necessary to water the concrete at night as well as during the day. The pump is of the outside packed type with 4 plungers set at 90 degrees with respect to each other, so that two are always on the suction and two on the pressure stroke, giving a steady flow at minimum pulsation. The 4-cylinder pump is driven by a 4-cylinder engine: the Le Roi in the 40 gal.-300 lb. size and by the "Hercules" in the 60 gal.-500 lb. size. Each engine is mounted in three point suspension and the truck frame is similarly mounted. This uniting, in connection with the rivetted-gussett plate construction of the truck frame insures permanent alignment of the pump and engine. In addition to the 40 and 60 gal displacement units the "Quadruplex" is also made in a 100 gal 300 lb. pressure size. The pump and engine are enclosed in a galvanized sheet steel housing with removable sides, thereby providing means for locking up the outfit at night.



"Quadruplex" Road Builder's Pump.

All Steel Plant for Storing, Measuring and Loading Concrete Aggregate

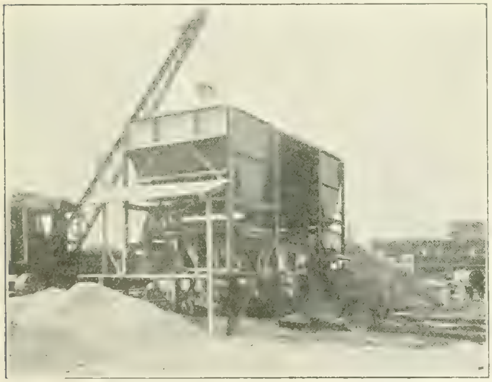
An all steel central proportioning plant for concrete aggregates has been placed on the market by the Erie Steel Construction Co., Erie, Pa. The plant consists of two principal units. The bins, and the "AggreMeters" or measuring devices. There is one bin for sand and one bin for stone, with a measuring device under each bin. The capacity of the bins is about 40 tons each, which allows for a temporary shut down of the equipment used for unloading the cars, although a storage pile is usually used in addition.

The sand and stone are unloaded direct from railroad cars into the large sand and stone hoppers of the AggreMeter, using either crane and clamshell or other unloading equipment. A storage pile beside the AggreMeter plant is used to provide for delays while placing of cars, etc.

At the bottom of the bins are gates for discharging the sand or stone into the measuring hoppers—the number of gates depending on the number of batches to be handled at once. For example, if the haul is by motor truck and each truck has four compartments of one batch each, there will be four gates at the bottom of the bin—and four hoppers in the measuring device.

Of special interest is the means provided for assuring accurate proportioning, at all times, of the sand and stone in the measuring hoppers or "AggreMeters." As these loaded boxes, each of exactly one batch capacity, are moved out over the truck, they must pass under a strike-off plate which fills up any pocket in the box, and levels off the top of the boxes exactly. This automatically measures the aggregate, and does away entirely with the necessity of raking down by hand.

The plant is built entirely of steel and is made in sections. It can be easily taken down and set up in one day, and can be moved to another site on three trucks, or on one flat car.



View of Complete Plant, Showing Crane and Clamshell Unloading Materials from Cars to Storage Piles and Hoppers of AggreMeter, Operator of AggreMeter Filling Stone Measuring Boxes from Bin; and Sand Boxes Over Truck, Just Dumped and Gates Closed Again.

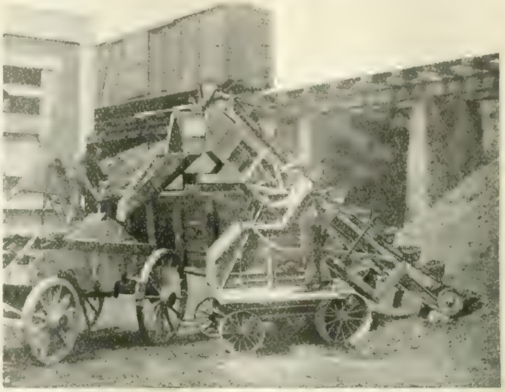
A New Power Loader

A loading machine recently brought out by the Link-Belt Company, and illustrated herewith has certain interesting features of design and operation which are described briefly as follows: The elevating mechanism is arranged to turn on a swivel in a horizontal plane, and the unit is self propelled, the combination of which 2 features makes possible the clearing of a path wide enough for the machine to move directly into the pile of material on which it is working.

The operator directs the digging end of the elevator in an arc. The maximum width of which is over 20 feet. When cutting reaches the end of each arc, the loader is advanced a short distance automatically towards the pile thus making a wide cut in the pile as far as required. Provision is made to prevent damage to the machine in case of buckets striking a hidden obstruction. It is not necessary to drag or scrape the material into the path of the buckets.

Since the hardest work required of a loader is the digging, the buckets are designed with special cutting edges. In addition, these edges are of different shapes on alternate buckets—one being in the form of an arc, its successor a rectangle, the next an arc, etc.

This feature permits of the bucket digging with a fresh surface, cutting with a portion of its edge only, and eliminating the heavy drag and shock to machinery occasioned by the entire bucket surface digging into the pile.



Handling Coal with the "Power Swiveling Loader."

The operator stands on a platform which turns with the elevator, permitting the operator to have the digging and discharge point in view at all times. All controls are in easy reach. The operator, being elevated above the ground and away from the moving parts, is free to center his efforts toward loading the greatest amount of material without giving thought to personal safety.

The loader can be operated by a 7½ H.P. motor or a 15 to 20 H.P. heavy duty gasoline engine. It has speeds of 5 and 75 ft. per minute, both forward and back. Its collapsed height for clearing overhead obstruction or for storage is 9 ft. 8 in.

The working capacity of the loader is 45 cu. ft. of loose materials per minute. Its simplicity of operation is such that it can be used by an unskilled man after a little training.

Industrial Notes

The Cleveland Tractor Co. announces the appointment of Earl B. Stone as advertising manager, succeeding G. B. Sharpe, resigned. Mr. Stone has been with the Cleveland Tractor Co. 2½ years, serving as sales representative, assistant advertising manager and district sales manager. His former advertising experience included work with The General Fireproofing Co. of Youngstown, O., and with The National Acme Co. of Cleveland.

The Kissel Motor Car Co. will have an interesting exhibit at the National Good Roads Show to be held at Chicago, Jan. 16 to 20. In addition to a completely equipped special Kissel road builder's truck, quarter size working models of the Kissel patented hopper and measuring boxes and specially designed turntable will be shown.

The Chain Belt Co., Milwaukee, Wis., will exhibit its 1922 model of the Rex Paver at the National Good Roads Show, Chicago. This machine has the enclosed type of transmission. Another distinctive feature is the enclosed power operated discharge of the Rex paver. All gears operate in oil so that the manipulation of the discharge chute is not only very easy but also remarkably fast. The swinging of the chute responds almost instantly to the touch of the lever. The paver on exhibition will be equipped with the full length type of traction, adapted to the three point suspension principle. A new type of Rex distributing bucket will also be shown. The company also plans to exhibit a central mixing plant mixer with features that are a radical departure from present mixer standards.

Trade Publications

The following trade publications of interest to engineers and contractors have been issued recently.

Street Flushers.—Tiffin Wagon Co., Tiffin, O. Bulletin illustrating and describing Tiffin 2-motor system of street flushers and sprinklers.

Sheet Asphalt Pavements.—The Texas Co., 17 Battery Pl., New York City. Booklet describing methods of constructing Texaco sheet asphalt pavements. It is illustrated by photographs and cross sections bringing out important points in text.

Crawling Tractor Cranes.—Industrial Works, Bay City, Mich. Catalog No. 113, illustrating and describing the Type BC "Industrial" crawling tractor crane of 20,000 lb. capacity for road contractors, lumber and coal dealers, gravel, sand and stone producers, foundries, railroad reclamation and storage yards and moderate size manufacturing plants.

Waterworks and Hydraulics Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 9 South Clinton St., Chicago.

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Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) [illegible] Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Management and Office System

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The City's Position in the State Government

On the basis of population New York City is inadequately represented in the New York State Legislature, and there are strident complaints of interference by an upstate majority in affairs that belong primarily to the metropolis, such as the control of transportation within the city. Chicago is in a similar, though less aggravated position and there has been newspaper expression of a fear that the constitutional convention of Illinois may still further reduce the proportion of that city's representation in the Legislature, and leave it subject to the same form of "oppression" that New York City suffers at the hands of the State.

Certain it is that there are often conflicts of interest between a metropolis and an outlying or remote rural territory, and it is fair to inquire if some of our great cities may not wisely be separated from their state government, and given a rank of statehood or something equivalent thereto.

It is argued that the "city-state" has never been a success, but this argument, we think, involves a confusion of definitions. The city-state as a sovereign power may have left much to be desired, but such a status does not concern us now. It is vastly different from what would be the position of a great city as an integral member of the United States of America. Europe affords some very excellent examples of cities having such a status, the most notable from the standpoint of commercial success being Hamburg. That city is the capital of the state of Hamburg, whose total area is only 160 square miles, and for practical purposes the city is the state. The city of Bremen as the capital of a state whose total area is 99 square miles affords a similar example, and to the list there may be added the Russian cities of Petrograd, Odesso and Sebastopol as they were before the revolution. These cities were all prosperous, and were important ports and centers of commerce. Our list is not complete, but we ought certainly to note our own city of Washington and District of Columbia as a significant success in spite of the very special purpose of their organization.

Among governmental units subject to complete free trade, as are the various subdivisions of the United States, we can see no real necessity for the attachment of a large city to a particular section of back country. State boundaries do not limit the territory tributary to New York, nor do they materially affect the centering of business from the entire middle west at Chicago. If southeastern New York had been erected into a state of the size of Delaware, we believe that the commercial supremacy and general civic greatness of the city on Manhattan Island would be in no wise altered. And if a state no larger than Delaware, then why not one smaller still?

The cities, we believe, would benefit from the separation. The country would lose some exceedingly desirable taxes but otherwise would probably gain; and as for fairness, Chicago might just as well be taxed for the benefit of portions of Indiana, Michigan and Wisconsin as for the benefit of Illinois.

There is always somewhat of a conflict of ideals between the city and the country. The city scorns the country's slowness and narrowness, and the country abhors the city's arrogance and corruption. Each may exercise a somewhat wholesome restraining influence upon the other, but it is questionable if such influence is improved by their association and enforced co-operation in a single self-governing state.

We do not say positively that cities and states should separate; and in any event the cases of separation should probably be few. The problem involved would need much study, and after all might be solved positively only by trial, but it is worth thinking about.

1922 Should Witness More Water Works Activities

Like other institutions whose business permitted retrenchment, the water systems of this country have been passing through a period of deferred maintenance and non-expansion. The effects of deferred maintenance develop more slowly in water plants than in many other classes of utilities and industries, but they are not negligible, and sound management requires that repairs be undertaken as soon as material and labor prices have descended to approximately stable levels. A few repairs are so pressing as to enforce disregard of prices; in the case of certain others, economy will be served if they are carried out without further waiting for the limit of price reduction; while still others may be postponed a considerable time without involving any consequences which would warrant paying more than a reasonably anticipated minimum for them.

It is impossible to tell with certainty whether or not the prices of pipe, other materials, and labor entering into waterworks construction and repairs have as a whole reached a minimum which will endure. The U. S. Bureau of Labor Statistics' index price of all commodities has hovered between 148 and 154 ever since April, 1921, the November number being 149; and as has been pointed out in these columns before, there is good reason to think that it will stay in that vicinity for some time to come. While the prices of particular commodities will not all follow the average course, there is at least a tendency for them to swing that way, and eventually some which are still far from the average undoubtedly will settle close to it.

In November and December, 1921, the prices of cast iron pipe at Chicago were respectively 64 and 66 per cent above the average of the five years ending Dec. 31, 1913. These correspond to index prices of 164 and 166. But the five year average of pipe prices to Dec., 1913, is substantially lower than any corresponding average since 1903. In fact the pipe prices of November and December, 1921, are less than 48 per cent above the averages for any of the five year periods terminating between 1906 and 1910. The present price of cast iron pipe, therefore, is at at least as low a level as the average price of all commodities. Galvanized steel pipe is almost at the same level. Galvanized iron pipe is still substantially higher. Lead is just about at its pre-war price, and will probably increase. Labor in some places is as low as can be expected; in others it is still high. On the whole, it is questionable whether any material saving in the cost of work can be effected by further postponement; while work which for any reason is pressing will almost certainly involve a loss if delayed.

Our deficiency in residential development and our national housing shortage are too well known to need comment. There is pressure for relief, and some of it will come this season. A great deal will come if conditions in the building industry are improved. And with it, of course, will come proportionate development and extensions of water and sewer systems and other utilities. The increase in water purification has not escaped its set-back from normal, and there should now be a marked activity in this field.

All in all we think that 1922 must run well ahead of any of its immediate predecessors in waterworks and sanitary activities, and there is an excellent prospect that it will develop into a genuine banner year.

Bleaching Powder in the Tropics.—In the Journal of Chemical Industry for Oct. 15, Capt. A. F. MacCulloch states that tests on the stability of ordinary bleaching powder and on "stabilized bleach" (bleaching powder mixed with 20 per cent of powdered quicklime) extending over a period of two years as made at the government laboratory at Madras, India, showed that stabilized bleach decomposes at a fairly steady rate and remains a dry powder in a high temperature, while ordinary bleaching powder decomposed rapidly due to formation of water. Due to the fact that the stabilized bleach contained 5.9 per cent calcium chlorate at the end of two years and this amount of chlorate would give a nauseating taste to the water upon treatment, Capt. MacCulloch recommends that the stabilized bleach be used in the tropics within a year of procural.

The Appendix of a Technical Book

By R. FLEMING,
American Bridge Co., New York City.

The Appendix is the Soul of a Book.—Old Proverb.

A habit of examining the appendix of a book, directly after reading the preface, has often given profit as well as delight. Especially has this been the case with technical books, for about all the time can be given to many books of this class is that required for reading the preface and the appendix.

The Century Dictionary defines the appendix: "An addition appended to a document or book relating to the main work, usually consisting of explanatory or statistical matter adding to its value, but not essential to its completeness, and thus differing from a supplement, which properly is intended to supply deficiencies and correct inaccuracies." Where this definition is followed the appendix can be read apart from the main body of the work. Earle, "The Theory and Practice of Technical Writing," in his directions to technical writers, says, "If the matter should be read by all, it is an essential part of the subject and should be incorporated as an organic part of the text; if it is not essential and would seriously interrupt the direct development of the exposition yet would be of value to some readers it may well be inserted as a footnote or Appendix."

Just what the appendix may contain of interest is best seen from specific examples, more or less typical.

"The Book of the Machine Gun," an English work by Longstaff and Atteridge, gives in an appendix an unusually complete "Bibliography of Unofficial Books, pamphlets and articles concerning the subject of machine guns." The 40 pages begin with a lone entry under 1862 and close with 1916.

Green, "Wharves and Piers," in an appendix, "Cost of Walls, Piers, Sheds, etc.," gives 13 pages of the detailed costs of structures as built.

In Kunz, "Design of Steel Bridges," Appendix A is entitled, "Actual Pressure of Foundations in Bridge Work, in tons per sq. ft.," and Appendix B, "Actual Pressure of Foundations in Structural Works in Tons per sq. ft." Original data are thus made available.

In Fowler, "Engineering and Building Foundations," 1920, "Selections from Specifications," Appendix I to Appendix X, fill 70 pages.

An engineer will often find in the appendix of a technical book a short treatise that is of real worth. For instance, Appendix "C" in Johnson, Bryan and Turneaure's "Modern Framed Structures," Part III, is a valuable monograph on Unsymmetrical Bending." It would be difficult to find elsewhere a more lucid explanation of the "S" polygon. Appendix 1, Cain's "Earth Pressure, Retaining Walls and Bins," is a treatise of 30 pages: "Stresses in Wedge-Shaped Reinforced Concrete Beams."

Some British works will be quoted:

"Reinforced Concrete Design," Faber, Vol. II, 1920, Appendix II, pages 175-203: "A Study of Moments in Beams, Allowing for Stiffness in Columns," begins, "In the author's opinion, only the most skillful and experienced engineers should consider this treatment—for all others it is dangerous." He proceeds, "Nevertheless the author attaches the utmost importance to it, since it puts within the reach of all, for the first time, the absolutely accurate treatment of moments, taking live and dead load and stiffness of columns into account."

"Engineering Construction," Warren, Part II, 1921, Appendix, pages 485-494, is introduced by, "The following method of analysis of the stresses in the rigid arch rib has been developed by Mr. W. A. Miller, Lecturer in Civil Engineering, University of Sydney. The method possesses many advantages and will in the author's opinion, be found to be a valuable addition to the literature on the subject."

"Strength of Materials," Morley, 1920, Appendix, pages 531-538 determines, "Tension in a Plate Perforated by a Single Circular Hole."

The foregoing instances of the useful and the unusual found in Appendices could easily be multiplied. They are however sufficient to show that an engineer whose time is limited, may, if before a shelf of technical books, often find enjoyment by giving his attention to the appendices therein.

Characteristics of Some Connecticut Sludges

Their Composition, Treatment and Possible Utilization Discussed in Paper Presented Before Boston Society of Civil Engineers

By J. FREDERICK JACKSON and JOSEPH DOMAN.

Director and Assistant Chief of Engineering, Connecticut State Department of Health

One very important feature in the design and operation of sewage treatment works and one heretofore too often given the least consideration is the treatment and disposal of the sludge. No investigation of sewage from large cities can today be considered complete that does not include a careful study of the economic treatment and utilization of the sludge. The feasibility of recovering nitrogen and extracting grease from sludges, burning for fuel value or developing gases for generation of power has been at times demonstrated with varying degrees of success, but where such utilization was practiced, local conditions were particularly favorable and a successful method of general applicability still remains to be found. In fact, local conditions and requirements, rather than sludge utilization, govern the selection of sewage and sludge treatment for any particular community

Analytical data concerning these sludges is found in Table I while Table II shows the composition of the sewages from which the sludges were produced.

Grit Chamber, New Britain, Comparison of Grit and Scum.—The grit chamber at the New Britain station treated an average of 90,000 gal. per day with a retention period of half a minute; inlet velocity of .4 ft. per second, outlet velocity 9 ft. per second. A small baffle across the outlet end retained considerable scum on the surface of the chamber. The grit was black in color, very odorous, and at times contained comparatively large amounts of matter other than true grit, such as spaghetti and pieces of vegetables. The scum differed in appearance from time to time, frequently resembling a heavy dark oil and at other times a dark yellowish grease. It usually had a stale greasy odor.

The grit and scum were practically identical in moisture content, which was very low, averaging about 52 per cent, and in nitrogen content, which was also very low, averaging about .7 of 1 per cent. There was, however, a marked difference between them in other constituents of the grit, 75 per cent was mineral matter while the scum contained 80 per cent volatile matter. Ether extract, both plain and acid, were at least ten times higher in the scum than in the grit. Theoretically, the scum should be quite valuable from the standpoint of grease extraction, as it contained 63 per cent plain ether extract. Actually, however, the amount of scum was so small that only 4.2 lb. of plain ether extract would be produced per million gallons sewage or about 16 lb. per day from the total New Britain sanitary sewage

Drying on sludge beds and dumping on spoil land would be the simplest method of disposal of both grit and scum. After drying on the beds, the scum, however, could probably be mixed with coal and burned under boilers, as the amount of volatile matter would be very high and the moisture quite low.

Test of the Screenings.—A seven day performance test was made on the New Britain sewage using a standard Dorrco drum screen with slotted perforations 1/16 in. by ½ in. and screening the total flow of 3.3 million gallons per day. On the million gallon basis 30 cu. ft. of wet screenings were obtained with the comparatively low moisture content of 81 per cent. These were quite dry and in spadable condition as delivered by the bucket elevator. Dry solids amounted to 380 lb. per million gallons, representing a removal of 21.3 per cent of the total suspended solids from the crude sewage.

The screenings, gray in color, were a mixture of all sorts of sewage solids often containing considerable garbage. When spread on the ground, the screenings dried quite rapidly but with a pronounced foul odor in the immediate vicinity during the first three or four days' drying. Flies bred profusely, indicating the necessity of treatment with a fly repellant while drying. At the present time the screenings are disposed on spoil land without any preliminary drying on beds. This method appears quite satisfactory.

Imhoff Tank Sludge, New Britain.—As drawn from the tank, this sludge was a thick black liquid having a tarry and somewhat offensive odor. Moisture content ranged from 84.8 per cent to 92.6 per cent averaging 90 per cent. There was no marked progressive loss in percentage of moisture with storage. From the dry basis tests, the various constituents of the sludge remained quite uniform throughout a storage period of about a year Of the dry solids 48.3 per cent were mineral matter, 2.37 per cent nitrogen, 14.3 per cent plain ether extract and 19.5 per cent acid ether extract. From volumetric measurements, combined with specific gravity and moisture tests, progressive digestion was noted with storage. Comparatively fresh sludge, after three months' storage, amounted to 72 cu. ft. per million gallons, which at the end of one year's storage was reduced to 46 cu. ft. Dry solids in the fresh sludge amounted to 470 lb. per million gallons and after one year's storage to 322 lb. Comparing the sludge solids with the amount of dry solids removed by the Imhoff tank, as shown by the suspended solids tests, the digestion of solids amounted to 36 per cent after one year's storage.

With regard to moisture, mineral matter and nitrogen content, the Imhoff tank sludge at New Britain was almost identical with that obtained at Worcester, Mass., and Baltimore, Md. It is particularly interesting to note the very small difference in the nitrogen content of these sludges, that at New Britain being 2.37 per cent, Worcester 2.63 per cent and Baltimore 2.75 per cent.

At New Britain, the sludge dewatered very readily on drying beds. In one of the experiments during the summer the sludge was applied to a depth of 12 in. on the beds and was removed in spadable condition after two days' drying.

Secondary Tank Sludge, New Britain.—This sludge was obtained from plain sedimentation of the sprinkling filter effluent. The retention period in the tank was about one hour. The sludge was very similar in appearance, though noticeably more putrescible than the Imhoff tank sludge. There was but little difference in chemical composition of these two sludges. The tank was cleaned at intervals of from two weeks to two months and therefore comparatively little sludge digestion would be expected. The dry solids recovered in the sludge were practically identical in amount with that removed from the filter effluent after passage through the tank. The dry solids recovered in the sludge amounted to 385 lb. per million gallons, the suspended solids removed from the filter effluent to 380 lb. per million gallons. The volume of wet sludge per million gallons sewage amounted to 94 cu. ft., this being about 20 per cent greater than that from the Imhoff tank.

The sludge dewatered readily on sludge drying beds but in actual practice it could be returned to the digestion chamber of the Imhoff tank and allowed to digest with the sludge prior to drying on beds.

Miles Acid Sludge, New Britain.—This was a rather thick, gray, greasy liquid with a pronounced foul odor. The moisture content averaged 95 per cent. Averages on the dry basis were, nitrogen 3.1 per cent, plain ether extract 21.6 per cent, acid ether extract 30.3 per cent.

A peculiar feature of the Miles acid sludge was its low dry solids content. The suspended solids tests on the sewage influent and effluent showed that the dry suspended solids removed from the sewage amounted to 767 lb. per million gallons, while the dry solids in the sludge were only 308 lb. per million gallons, or 40.1 per cent of the suspended solids removed from the sewage. There may have been some sludge digestion but in view of the germicidal action of the acid and the absence of any gas bubbles rising to the surface of the tank, digestion, if any, must have been very slight. It is very probable that the dissolving action of the acid removed considerable of the suspended solids from the sewage, these passing off in solution in the effluent and not being recovered in the sludge. This would seem to be borne out by the iron determinations. The weighted average of all the Miles acid runs showed that the effluent contained 7.8 per cent more iron than the influent, and while iron precipitates could be observed in the influent they were not observed in the effluent, being obviously in the dissolved form in the latter. The increse in iron content was traced to the action of the acid in attacking iron piping in the tank, parts of which were completely eaten away.

Another indication of the solvent action of the acid on suspended matter is by comparison with the results from the Imhoff tank. This removed 44.8 per cent of the suspended matter and 25.8 per cent of the organic nitrogen from the sewage, very little of the organic nitrogen changing to the ammonia form. The Miles acid process, on the other hand, removed 76.5 per cent of the suspended solids, and as judged by the Imhoff tank removals, we would expect a removal of 44 per cent of organic nitrogen. The actual removal of organic nitrogen, however, was only 7.3 per cent, the effluent containing 92.7 per cent of that in the crude sewage. We can account for this in no other way than the solvent action of the acid on some of the suspended solids which prevented their precipitation.

The Miles acid sludge dried very slowly and with considerable odor on well drained sludge beds.

Sedimentation and Lime Treatment, South Manchester.—The tank retention period for both treatments was approximately four hours. Lime dosage was 0.2 gram per liter or 1,660 lb. per million gallons. From the standpoint of sewage purification, there was very little difference between these two treatments but in several respects the sludges were quite dissimilar.

Lime treatment produced about three and three-quarters times as much sludge as plain sedimentation, the figures per million gallons being 607 cu. ft. and 162 cu. ft. respectively. The dry solids in the sludge were in about the same proportion, lime treatment producing 1,760 lb. per million gallons, plain sedimentation 455 lb. Nitrogen concentration, however, was considerably higher in the plain sedimentation than in the limed sludge, the figures being 4.62 per cent and 1.48 per cent respectively. At the same time there was but little difference in the total amount of nitrogen recovered in the sludges per million gallons of sewage, lime treatment producing 26 lb. and plain sedimentation 21 lb. The difference in concentration is obviously due to the large amount of non-nitrogenous precipitates from lime treatment.

Activated Sludge, New Britain.—At the present time activated sludge is the most interesting of all sewage sludges on account of its possible utilization as a fertilizer base and also on account of the difficulty experienced in economically dewatering it. But little attention, however, has been given to some phases of the actual derivation of this sludge and a brief discussion of these may be helpful in our understanding of the changes which take place in it.

With the exception of chemically precipitated sludges, sewage sludges are the result of the removal of suspended matter from the sewage. Activated sludge, however, in our opinion, is derived from some dissolved as well as the suspended matter and if this is true it will explain some things in connection with the digestion of activated sludge and fixation of nitrogen from the air by certain sludge organisms which heretofore have not been satisfactorily accounted for.

In relation to the precipitation of dissolved organic matter into the sludge, the following figures are rather suggestive. Based upon the results from the Imhoff tank and 80 per cent removal of suspended solids from the sewage would effect a removal of 46 per cent of organic nitrogen. Actually, however, with about 80 per cent removal of suspended solids by the activated sludge process we find a corresponding removal of nearly 70 per cent of organic nitrogen, or about 52 per cent greater than the expected removal if the organic nitrogen were derived entirely from the suspended solids. Digestion or oxidation may account for some of this extra removal but it seems much more likely that it is due to the assimilation of the dissolved organic nitrogen by the sludge organisms.

Taking the figures for oxigen consumed, we would expect, with 80 per cent removal of suspended solids, 39 per cent removal in the oxygen consumed. Actually, however, we find that the activated sludge process effects a removal of 65 per cent in the oxygen consumed figure with 80 per cent removal of suspended solids. In this case also, oxidation and digestion may account for some of this removal but it seems more logical to assume that the assimilation of organic matter originally in the dissolved form in the sewage is responsible for the high reduction in the oxygen consumed figure.

The question of removal of dissolved organic matter can, of course, be settled quickly by comparing amounts and removals of matter in solution and suspension as well as total constituents, but unfortunately all the data at hand give results on total constituents in the sewages and effluents and no attempt has been made to segregate them into the dissolved and suspended forms. If studies along these lines were available, our knowledge of this phase of the activated sludge process would be much more definite than it is now.

If we admit, however, that dissolved organic matter is removed from the sewage, it seems logical to assume that it has been assimilated by the sludge organisms as part of their food supply. This would very naturally affect computations pertaining to sludgectigation. If we base these computations on the removal of suspended solids only from the sewage, we find a very low percentage of digestion, the figures for Chicago and New Britain being 5.0 per cent and 5.5 per cent respectively, and from the intense biologic action in the sludge we would naturally expect digestion of sludge solids to be considerably greater.

Further, the question of digestion is important from the standpoint of fixation of nitrogen from the air by certain sludge organisms, some investigators having found that some of the organisms often present in activated sludge actually possess the power of fixing nitrogen from the air. In judging fixation, a nitrogen balance is computed and if the amount of nitrogen recovered is less than the input, it has been customary to assume that there has been no fixation of nitrogen from the air. However, it is still quite possible that there may have been some fixation, but that the digestion has been so great as to offset the recovery of nitrogen both from the sewage and atmosphere. It is interesting in this connection to note that while digestion, both at Chicago and New Britain, amounted to about 5 per cent of the suspended solids removed from the sewage, the actual loss of nitrogen at Chicago was greater than 30 per cent and at New Britain amounted to 20 per cent. If we attribute this loss to digestion, as seems logical, we must conclude that the percentage digestion cannot be computed from the suspended solids alone

TABLE I—SLUDGE ANALYSES.

Sludge	[illegible]	[illegible]	Dry basis tests [illegible]	% volatile	% nitrogen	Ether extract % plain	% acid	Per million gallons sewage Cu. ft. wet sludge	Lbs. susp. sol. removed from sewage	Lbs. dry solids in sludge	% recovery susp. sol.	Lbs. nitrogen in sludge	Lbs. plain ether ext. in sludge	Lbs. acid ether ext. in sludge
New Britain.														
[illegible]	[illegible]	[illegible]	[illegible]	25.2	0.70	2.9	6.6	0.18	.	6.6		0.42	0.17	0.40
[illegible]	[illegible]	[illegible]	[illegible]	39.8	0.68	62.7	66.5	0.28	.	6.7		0.46	4.21	4.56
[illegible]	[illegible]	[illegible]	[illegible]	....	....	....	....	30	....	180	....	....	....	....
[illegible]	[illegible]	[illegible]	[illegible]	51.7	2.37	14.3	19.5	772	525	†470	†89.5	†11.1	†67.2	†91.5
[illegible]	[illegible]	[illegible]	[illegible]	48.5	2.88	12.0	22.8	94	380	383	100.7	11.0	46.0	87.3
[illegible]				....	....	....	....	166	905	853	94.3	22.1	113.2	178.8
[illegible]	[illegible]	[illegible]	[illegible]	64.6	4.10	13.0	19.3	2,950	859	810	94.5	33.2	105.3	156.2
[illegible]	[illegible]	[illegible]	26.5	73.5	3.10	21.6	30.3	95	767	308	40.1	9.6	65.5	93.4
South Manchester.														
[illegible]	[illegible]	[illegible]	26.6	73.4	4.62	29.2	37.5	162	470	455	96.8	21.0	132.8	170.5
[illegible]	[illegible]	[illegible]	[illegible]	60.5	1.48	21.3	....	607	524	1,760	..	26.0	374.5	....

[illegible]

TABLE II—SEWAGE ANALYSES
(P.p.m.)

Determination	New Britain	South Manchester
Nitrogen as		
Organic	[illegible]	[illegible]
Free ammonia	[illegible]	[illegible]
Nitrites	[illegible]	0
Nitrates	[illegible]	0.57
Oxygen consumed	[illegible]	111
Total suspended solids	[illegible]	183
Volatile suspended solids	[illegible]	134
Chlorine	[illegible]	45
Alkalinity	[illegible]	70

but that allowance must also be made for the dissolved solids assimilated by the sludge organism.

As removed from the settling tank at New Britain, the activated sludge was usually reddish brown in color, due to the iron in the crude sewage. During prolonged periods of low iron content in the sewage, the sludge was gray in color, not unlike the slime characteristic of sprinkling filters receiving purely domestic sewage. The sludge was well flocculated but contained a noticeable amount of grit and coarser solids such as pieces of paper and vegetables. These latter no doubt were due to the fact that the sewage was not screened prior to activation. As wasted from the settling tank, the sludge was found to be quite light, with a specific gravity of 1.004. Moisture content was very high, averaging 99.56 per cent. About two thirds of the dry solids were volatile. Nitrogen content was comparatively low as compared with most activated sludges, averaging 4.4 per cent. Plain ether extract amounted to 13.0 per cent, acid ether extract 19.3 per cent. A comparatively large volume of sludge was produced averaging 22,100 gal., or 2,950 cu. ft. per million gallons sewage. Dry solids, however, were comparatively low, averaging 810 lb. per million gallons sewage.

The most effective treatment and disposal of activated sludge is by no means a settled question and considerable experimental work is still being done on this problem, particular attention being given to preliminary processes which will dewater the sludge sufficiently to make subsequent treatment feasible and economical. In this connection, a recent process, acid heat flotation, was quite thoroughly tested at New Britain through the courtesy of the Dorr Co., of New York City, and a brief description of the plant and summary of results may be of interest.

The Acid Heat Flotation Process.—The process consists essentially of first adding acid to the sludge and then heating the mixture. With proper design and operation, the results are two fold, first the actual contraction of the sludge particles and second, the flotation of these particles to the surface of the tank where further dewatering and contraction takes place.

In the tests, at New Britain, both sludge and acid were fed from constant head orifices to a large funnel discharging into the inlet pipe of the flotation unit. This unit was a galvanized iron tank 6.5 ft. deep and 2 ft. in diameter set inside a 4 ft. diameter wooden tank. Concentric with the other tanks and at the bottom was a small galvanized iron tank 2.5 ft. high and 1 ft. in diameter, forming a small reaction chamber. A small spiral coil, fed with live steam, was placed in this chamber. The inlet to the unit was through the bottom of the reaction chamber, the sludge flowing upward past the heating coil, the effluent being taken out at the bottom of the tank outside the reaction chamber. After heating, the sludge particles continued to float to the surface, overflowing into a collecting launder which discharged into a cart. The unit as described was operated on the continuous flow principle, treating the sludge at a rate of 4,150 gal. per day or 173 gal. per hour. During the last five consecutive days of the flotation tests, the operation of the process was practically uninterrupted.

Average results over the entire testing period of about 2½ weeks were briefly as follows: The moisture content was reduced from 99.55 per cent to 88.2 per cent, the volume of sludge being reduced to one twenty-sixth, or 3.8 per cent of the original volume. The lowest moisture content for a daily composite sample of the floated sludge was 84.5 per cent. On the dry basis, ammonia nitrogen averaged 5.85 per cent and acid ether extract 16.2 per cent. The average specific gravity of the floated sludge was 1.03. Of the total suspended solids in the influent sludge, 78.6 per cent were recovered in the floated sludge, the remainder passing off in the effluent. Of the ammonia nitrogen input 76 per cent were recovered in the floated sludge and of the total iron input 79 per cent. These recoveries were not as high as would be desirable, but considering the experimental nature of the flotation unit, which was the first fairly large installation of its kind, perfect design and operation were not to be expected. The unit, furthermore, was operated 16 out of the 24 hours per day by unskilled labor. Due to these causes, there were times when considerable amounts of suspended matter were present in the effluent, which lowered the amounts of recovered constituents in the floated sludge. In spite of unfavorable conditions, however, the effluents were for the most part quite clear and often contained less than 100 p.p.m. of suspended solids, the lowest recorded being 55 p.p.m. Turbidities as low as 20 were often noted. In this particular effluent the suspended solids were approximately three times the turbidity, indicating that the suspended matter was quite heavy. Particles of grit and pieces of paper were, in fact, plainly visible in samples of the effluent. With a properly designed and operated plant, an effluent containing not more than 100 p.p.m. suspended solids might be expected and recovery of suspended solids and nitrogen in the floated sludge should be well over 90 per cent.

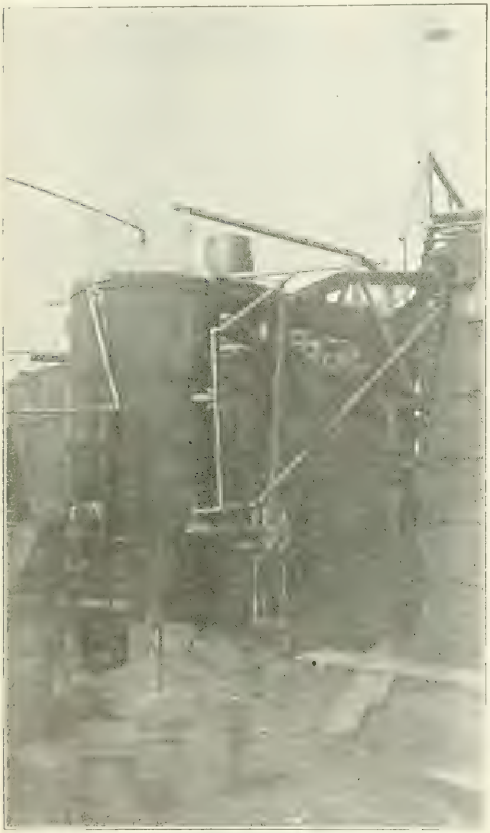
Floated Activated Sludge After One Week on Drying Beds.

Conditions at New Britain required the following operating rates: Retention period in reaction chamber, 8 minutes; temperature of effluent 30° C., which was 15° C. above that of the influent sludge; acid dosage, 1 c.c. H_2SO_4, sp.gr. 1.84, per gallon of sludge. The acid was usually applied in a 2 per cent solution. Qualitative experiments indicated that both acid and heat were necessary, as neither alone produced proper flotation.

The floated sludge dewatered very readily when spread on rather hard impervious ground to depths varying from 4 to 16 in., dehydration cracks appearing in all piles within 24 hours. The following moisture contents summarize the results of drying several cartloads of floated sludge in this manner:

Influent sludge, 99.4 per cent moisture.
Floated sludge, 89.2 per cent.
One day drying, 77.1 per cent.
Two days' drying, 66.5 per cent.
Three days' drying, 59.7 per cent.
Three weeks' drying, 26.4 per cent.

Most of the drying occurred during the first three or four days and was due largely to the drainage of water from the sludge. Evaporation of moisture seemed to predominate after that time. The result of these experiments was conclusive that the activated sludge could be concentrated and dewatered by the acid heat flotation process sufficiently to render it amenable to drying on beds. This would render the final drying, either by direct or indirect heat, considerably less expensive than for filter press sludge. It is only fair, however, to assume that filter press sludge could be dried equally well on beds so that the saving in cost of heat drying between the two sludges is more apparent than real.



Acid Heat Flotation Plant, New Britain Sewage Experiment Station.

Other Methods of Sludge Dewatering.—Drying on beds is the most common form of sludge treatment, but unfortunately this simple and economical method cannot be used for all sludges or in all localities. From our observation, grit, screenings, the sludges from settlings, septic or Imhoff tanks usually dry readily to a spadable consistency. Some limmed sludges also dewater satisfactorily on sludge beds, but with others clogging of the beds, apparently by lime soaps, is quite a problem. With Miles acid sludge, severe clogging of the beds took place. Untreated activated sludge, due to its rather gelatinous nature, quickly formed an impervious deposit on the surface of the sludge beds and the amount of drainage from the sludge was negligible.

Centrifuges have been successfully employed on sedimentation sludges in Germany and experiments with the Basco ter Mer continuous centrifuge were made on the Milwaukee activated sludge. A low moisture cake, less than 80 per cent, was obtained, but about half of the suspended matter was lost in the effluent. As this would result in undesirable pyramiding of the sludge if returned to the aeration tank, this method is not regarded as entirely satisfactory.

Filter presses have been successfully used to dewater limed sludges at several large plants in this country. Considerable work has also been done in filter pressing activated sludge, best results being obtained by acidifying the sludge prior to pressing. This method has produced sludge cake with as low a moisture content as 75 per cent, but rather cumbersome operation and expense of treatment are serious disadvantages. As to the relative merits of sludge flotation and filter pressing, we believe that the flotation process is much simpler to operate and very probably more economical than filter pressing, although the latter process will produce a sludge of somewhat lower moisture content. This last feature loses its importance, however, if the sludge is to be further dewatered on drying beds prior to heat drying.

At Milwaukee, in the early part of 1918, experiments were made by acidifying and settling activated sludge, reducing the moisture content in the sludge to about 91 per cent. This method was apparently unsatisfactory as no attempt was made to develop it into a practical and workable process.

The Maclachlan process, which is very recent, consists of burning sulphur, and forcing the fumes, mixed with live steam, through activated sludge. This process is being used at Houston, Tex., as a conditioner of the sludge prior to filter pressing, although the sludge, after treatment, is apparently amenable to drying on sludge beds. From the reports available, it appears that the process reduces the moisture content of the sludge from 98 per cent to 95 per cent, which is not as good as the results obtained with the other processes mentioned above. No data is given as to the percentage of suspended matter recovered in the sludge or the character of the effluent.

Suitability of Various Sludges for Fertilizer Base.—The concentration of ammonia nitrogen is the main criterion which determines the suitability of sludges for fertilizer base. Authorities quite uniformly agree that with less than 5 per cent of nitrogen in the dried material sludges are practically of no economic value as fertilizer. The Imhoff tank sludge at Baltimore, however, is a rather notable exception to this rule as this sludge has been sold for fertilizer on the nitrogen basis, which usually was somewhat below 5 per cent. At Rochester, too, the farmers are willing to pay sufficient to cover dewatering the sludge and haul it 5 or 6 miles for direct use on the land.

At New Britain, an interesting experiment was tried with the screenings. A plot of ground about three acres in area was sown to grass and fertilized with wet screenings applied in a thin layer. A surprisingly even and heavy growth resulted. For a number of years this same ground had been similarly sown but not fertilized and only sparse and patchy growths obtained. There was practically no odor or flies from the screenings and the results were so promising that the superintendent of the Sewage Disposal Plant intends to make further attempts to utilize the screenings for fertilizer during the next planting season.

At New Britain also, considerable sludge is obtained from the sand beds, which up to the present time were dosed with raw sewage. The sludge was air dried and attempts were made over a number of years to use it for fertilizer. These, however, were unsuccessful and the present method of sludge disposal is by filling in spoil land.

Of the sludges here considered, however, we can dismiss as unsuitable for fertilizer base those from the grit chamber, Imhoff tank, and secondary sedimentation tank at New Britain and lime treatment at South Manchester, leaving only the activated and Miles acid sludges at New Britain and plain sedimentation at South Manchester as being possibly suitable for this purpose. Of these three sludges, the activated sludge, after acid heat flotation, had the highest nitrogen concentration, 5.85 per cent. Plain sedimentation had 4.62 per cent and the Miles acid 3.1 per cent. The high nitrogen concentration in the plain sedimentation sludge is rather unusual for this type of sludge and may be accounted for by the fact that the raw sewage contained considerable dye wastes, some of which had as much as 1,600 p.p.m. organic nitrogen.

Our experiments furnish some rather interesting data as to the varying nitrogen concentration in different sludges derived from the same sewage. Comparing the Imhoff tank and Miles acid sludges at New Britain we find that the total amount of nitrogen per million gallons sewage in the former to be 11.1 lb. and in the latter 9.6 lb., yet the nitrogen concentration is greater in the Miles acid than in the Imhoff tank sludge. This is attributed to the solvent action of the acid on some of the sewage solids, preventing their precipitation into the sludge and thus resulting in somewhat higher concentration of those substances actually in the sludge. Thus at New Britain, we have the anomaly in the Miles acid process of very small removal of nitrogen from the sewage but a relatively high nitrogen concentration in the sludge.

The reverse of this action is well illustrated in the South Manchester sludges. For example, the lime treatment sludge contained, in the form of lime precipitates, considerable extraneous matter other than sewage solids so that we find the concentration of the actual sewage solids in the sludge to be proportionately reduced by the addition of these extraneous solids. Thus, while the nitrogen concentration of the plain sedimentation sludge amounted to 4.62 per cent, that of the limed sludge was 1.48 per cent, with a total recovery of nitrogen per million gallons sewage of 21 and 26 lbs., respectively

Activated sludge at New Britain contained about three times as much nitrogen per million gallons sewage as either the Imhoff tank or Miles acid sludges. The more complete removal of suspended solids by the activated sludge process cannot be regarded as sufficient explanation for this circumstance and it is our opinion that the high nitrogen concentration in the activated sludge is due to the assimilation of dissolved organic matter from the sewage by the sludge organisms and perhaps some fixation of nitrogen.

The suitability of sludge for fertilizer base is affected by factors other than the nitrogen concentration, such as availability of the nitrogen for plant food, the amount of phosphoric acid, the effect of fats and other chemical constituents of the sludge. Of the sludges here considered, however, the activated sludge appears to be the most promising for successful utilization as a fertilizer base.

Suitability of Various Sludges for Fat Recovery.—In general, sludges containing less than 15 per cent fats are not considered suitable for fat or grease recovery. This, however, is a rather indefinite statement since varying amounts of fats are obtained, depending upon the method used in making the analysis. Untreated sludge gives one result and sludges neutralized with sulphuric acid or treated with an excess of the acid give somewhat different results, due of course to the action of the acid on the saponified fats, and it is questionable whether or not these should be included. If fats are to be recovered at all, however, it is only natural to assume that the most complete recovery possible is meant and for this purpose, as at Bradford, England, the sludge would be acidified before extracting the fats. In this case, therefore, the most important test would be the acidified ether extract and the present discussion assumes that sludges containing more than 15 per cent acidified ether extract are tentatively suitable for fat recovery. With the exception of the grit, and possibly the screenings, all the sludges here considered contained more than 15 per cent acid ether extract, the highest being from the grit chamber scum, which contained 66.5 per cent. Plain sedimentation at South Manchester contained 37.5 per cent, and the Miles acid at New Britain 30.3 per cent. Imhoff tank, secondary sedimentation tank and activated sludge each contained approximately 20 per cent acid ether extract. Under present market conditions, it is doubtful if the extraction of fats from sludges of ordinary domestic sewages can be economically accomplished even with a concentration of over 15 per cent acid ether extract. For certain industrial wastes and extraordinary sewages, such as at Bradford, England, fat extraction might be profitable. It has been stated, however, that one of the advantages of the Miles acid process is that the sludge is much more suitable for fat extraction than other sewage sludges mainly because of its higher fat concentration. At New Britain, while the concentration of fats was higher in the Miles acid sludge than in the Imhoff or activated sludge, in actual operation after drying the sludges it is quite possible that there would not be any great difference in the suitability of these sludges for fat extraction due to concentration. As to the Miles acid sludge being superior to the other New Britain sludges, this is at least doubtful, even if sewage treatment is to be viewed from the standpoint of fat recovery rather than character of effluent. There can be no question that Imhoff tank treatment is considerably simpler and cheaper than Miles acid treatment, yet we find that Imhoff tank sludge, after three months' storage, contained 67.2 lb. plain ether extract per million gallons sewage while the Miles acid sludge contained 65.5 lb. As for the acid ether extract, the Imhoff tank sludge contained 91.5 lb. per million gallons sewage and the Miles acid 93.4 lb. The fat content of the activated sludge was almost double that from either the Imhoff tank or Miles acid, plain ether extract being 105.3 lb. and acid ether extract 156.2 lb. per million gallons sewage. As far as ultimate fat content is concerned, there is but little difference between the Miles acid and Imhoff tank sludges while the activated sludge contains considerably more than either, in spite of the fact that the concentration in the Miles acid sludge is about 30 per cent greater than in either of the other two.

Summary of Connecticut Experiences.—In general, our experience in Connecticut is that where area is available, as at New Britain, air drying and final disposal on spoil land is the simplest and most economical method of handling the sludges from plain sedimentation, Imhoff tanks, secondary sedimentation tanks and perhaps lime treatment. It is true that more or less offensive accumulations of sludge would be developed, which, under certain conditions, would be a nuisance, but better and more expensive disposal would only be warranted by the assurance of recovery values that will, in part, offset the increased cost. The outlook for this, with the sludges just mentioned is, however, not very promising.

Wet screenings, when applied to the land for fertilizing purposes, gave surprisingly good results. The experiment, however, was not carried far enough to be conclusive and more information is necessary to determine how feasible it is.

The most limed sluges filter pressing would probably be necessary. These sludges, apparently, do not offer much hope of successful treatment for either fertilizer purposes or other utilization.

A practical and economical method of dewatering Miles acid sludge was not developed. The pre-eminence of this method of treatment for producing a sludge particularly suitable for fat extraction was not shown.

Activated sludge, after acid heat flotation, air drying and heat drying would be readily adaptable for use as a fertilizer base. In the dewatering of activated sludge we believe that acid heat flotation possesses certain advantages, such as simplicity of operation, elimination of filter pressing and saving in cost of final heat drying. It probably will not reduce the moisture content as much as either filter pressing or centrifuging, but apparently it will be cheaper than either of these methods.

For localities which require completely inoffensive disposal of sludge, irrespective of cost, Imhoff tank sludge, activated sludge and Miles acid sludge could be dried and degreased and undoubtedly recovery values sufficient to cover part of the cost of treatment obtained. Existing conditions at each locality would decide the method of treatment to be adopted. Where only partial treatment of sewage is necessary, economy would indicate selection of the method producing an effluent and sludge similar to those from the Imhoff tank. Where a greater degree of purification is required, then activated sludge or the Imhoff sprinkling filter system, either with or without recently developed modifications, would be selected.

Practicing Engineers to Meet in Chicago—The American Association of Engineers will hold a conference of practicing engineers at the Congress Hotel in Chicago on Feb. 22. The tentative program includes the following subjects: How to sell engineering service; experience of the practicing engineer with licensing; publicity for practicing engineers; cost accounting for engineering service; bookkeeping for an engineering office; how to uphold the standards of services and fees.

State Control of Water Supplies

The activities which a state health department should conduct in undertaking comprehensive control of water supplies were outlined by the Committee on Water Supplies in a report submitted last year at the Regular Conference of State Sanitary Engineers. The Committee consisted of W. H. Dittoe, chairman; C. A. Emerson, Jr., Robert B. Morse, Albert H. Jewell and Ralph Hilscher. The report follows in part:

Present Practice of Water Supply Control in the Various States.—For the purpose of ascertaining the present activities and methods employed in the various states in the control of water supplies, the committee submitted inquiries to each state health department. Replies were received from [illegible] states and the committee has general information concerning the activities carried on in two of the states not replying. A review of the existing practice in the various states gives the following information: Some [illegible] states have established in their health departments a division of sanitary engineering. With the exception of a few of the older and more populous states the divisions of sanitary engineering are inadequately manned. At least 12 states have divisions comprising a single engineer and the vast majority of the divisions include a chief engineer with one to five assistant engineers. In each state having a division of sanitary engineering, control of water supplies is practiced, the completeness and effectiveness of which varies with the adequacy of the personnel. The approval of plans for proposed public water supply improvements is required in almost all of the states and in about half of the states the department is given the power to order improvement in public water supplies when found necessary. The extent of control of existing water supplies varies greatly in the different states and in many of them practically no state control is possible due to inadequate personnel. It is the general practice in the various state health departments to maintain a division of laboratories and to have all laboratory analytical work on water supplies performed by this division. In a few instances, however, a water laboratory is maintained as a part of the division of sanitary engineering.

The general conclusion from a study of the information furnished to the committee is that in most instances the divisions of sanitary engineering of the state health departments are inadequately manned to perform the duties which logically should rest upon such divisions. Additional personnel is necessary to provide adequate water supply control, to say nothing of the other important functions of such divisions.

Recommended Activities of State Health Departments in Control of Water Supplies.—The completeness and effectiveness of control of water supplies by a state health department may be measured by the reduction in typhoid fever death rates. Complete and effective control will not only prevent localized epidemics of typhoid fever but will accomplish a steady reduction in the number of scattered cases of the disease. The latter result will in fact ordinarily produce a greater reduction in rates than the reduction due to prevention of epidemics. It is therefore the judgment of the committee that complete and effective control of water supplies should be provided in every state, regardless of other duties imposed upon the division of sanitary engineering. Complete control of water supplies used by the people of a state demands recognition of (1) the public water supplies, those serving municipalities, districts and communities; (2) quasi-public water supplies, those serving institutions, schools, factories and other public and quasi-public buildings and places used for the assemblage or employment of persons; and (3) private sources of water supply installed for the use of individual families. Bottled waters used for drinking, beverage and medicinal purposes should be considered as quasi-public water supplies.

Recommended Activities for Water Supply Control.—Following is an outline of the activities which the committee recommends to provide for effective control of water supplies by the state health department:

1. Approval of proposed public and quasi-public water supplies by state health department.
   - (a) Approval of the source of supply and the plans for the development including the purification.
   - (b) Approval of the installation after it is completed and ready for use. (This is to insure that the work has been performed in accordance with the approved plans.)

2. Supervision of existing public and quasi-public water supplies by state health department.
   - (a) Inspections by the state health department to cover the following features:
     - (1) Adequacy of the supply.
     - (2) Possibility of contamination of source.
     - (3) Possibility of contamination due to improper development.
     - (4) Possibility of contamination due to inefficient purification works.
     - (5) Possibility of contamination in distribution, for example, by cross-connections, unsafe reservoirs, etc.
     - (6) Possibility of contamination due to emergency supply.
     - (7) Sanitary quality determined by analyses made in the field and in the department laboratory.
     - (8) Extent of use of the supply and for what purposes.
   - (b) Submission of reports to state health department by local officials.
     - (1) Reports on operation of water purification plants.
     - (2) Reports of regular analyses of water supply made in laboratories other than that of the state health department.
     - (3) Plans and records of existing works when required by the state health department.
   - (c) Issuance and enforcement of orders and regulations by state health department.
     - (1) Requiring proper general maintenance of system such as flushing of mains, cleaning of reservoirs and standpipes, removal of cross-connections, etc.
     - (2) Requiring proper supervision, analytical control and operation of water purification plants.
     - (3) Requiring abandonment of emergency intakes and pending such abandonment, requiring proper control of the use of the same.
     - (4) Requiring improvements to correct unsafe development of the supply, such as open well tops, leaky and unprotected reservoirs, leaky gravity lines, etc.
     - (5) Requiring abandonment of water supplies found to be impure and dangerous to health, and the installation of a satisfactory supply or a water purification plant.

3. Investigation by the state health department of the necessity of public water supply systems in municipalities and districts not provided with a public water supply. Based upon such investigations local officials should be urged to provide satisfactory public water supply improvements.

4. Effective control of water supplies demands control by the state health department of sewerage, sewage disposal and industrial wastes disposal. Such control should include approval or disapproval of proposed projects and enforcement of orders requiring improvements necessary to correct and prevent contamination of water supplies. This phase of work is wholly distinct from control of sewerage and disposal of sewage and industrial wastes for the purpose of preventing stream pollution and nuisances.

5. Application by the state health department of remedial measures to suppress waterborne typhoid fever epidemics.

6. Examination and approval by the state health department of water supplies for drinking and culinary purposes for common carriers. This work is to be carried on in co-operation with the United States Public Health Service.

7. Attention to private water supplies by the state health department is necessary, but the direct control of such supplies should be practiced by the local health officials. They should examine them and order their abandonment or improvement when necessary. It is the proper function of the state health department to furnish general information relating the proper location and development of private water supplies and your committee advises that this may be best accomplished through bulletins. The state health department should also actively urge the abandonment of private water supplies when a public water supply of satisfactory quality is available.

The placing in effect of all of the above listed activities cannot be accomplished at one time and without great effort. In most cases it will be found necessary to select the most important activities to be undertaken first and to be followed by the addition of those activities which are considered to be of lesser importance.

Flow of Water Through Spiral Riveted Steel Pipe

Data and results of an investigation upon the flow of water through 4, 6, 8 and 10 in. galvanized spiral riveted steel pipes are given in a recently issued bulletin of the Engineering Experiment Station of Purdue University. The experiments were begun in 1917 and later completed by the authors of the bulletin—F. W. Greve, Associate Professor of Hydraulic Engineering and R. R. Martin, Research Assistant in Hydraulics. The notes following are taken from the bulletin:

The Purdue experiments dealt primarily with the relation of friction loss to velocity for galvanized spiral riveted steel pipes in straight runs, both when the flow was directed with and against the laps. Secondary consideration was given to the effect of different kinds of piezometer connections upon the differential gage readings in connection with the experiments on the 6-in. pipe.

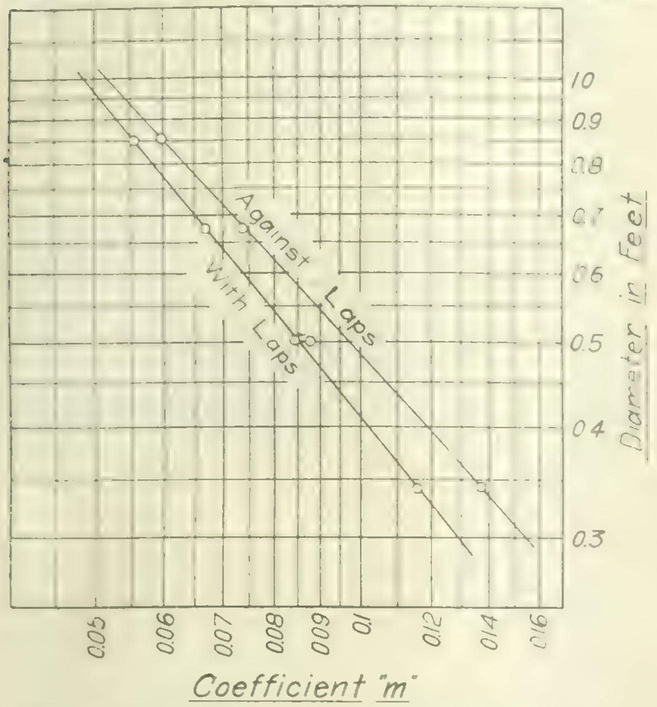


Fig. 1—Relation of m to d in the Equation, $m = k (d)^x$

Description of Pipe.—The spiral pipe was all of No. 16 gage, galvanized, and made up into approximate lengths of 4 and 20 ft. The several sections of pipe were held together by bolted steel flanges. In manufacturing, a strip of galvanized sheet steel about twelve inches in width is first formed into helical shape with overlapping edges so as to form a seam. The amount of overlap is about one inch on each side of the strip to allow for riveting. The average spacing of the rivets is ⅞ in. for the 4 and 6-in. pipe, 1 in. for the 8-in. and 1⅛ in. for the 10-in. pipe. The rivet heads on the inside of the pipe are flattened to reduce the resistance to flow.

Each spiral pipe line was laid horizontally and consisted of three sections each approximately 20 ft. long and a fourth section about 4 ft. long. Piezometer rings were inserted between the first and second and between the third and fourth sections from which rings the pressure was communicated through ¼-in. pipes to differential gages. The purpose of the first and last sections was to insure continuity of flow, the water being subjected to no change in the given conditions when entering and leaving the tested lengths.

Method of Testing.—The true diameters of the pipes were determined by the volumetric method.

A pressure gage was attached to the upstream piezometer ring in each setup to aid in controlling the pressure which was kept between 10 and 20 lb. per square inch to insure the differential gage against breakage and to make certain that the pipes were filled at all times. The valve at the pump was adjusted for a given rate of discharge and no data were recorded until the piezometer indicated a steady flow in the channel so that there was the same rate of discharge into the weighing tank as was passing through the pipe. The petcocks at the [illegible] and differential gages were opened [illegible] through and force out any air that might be trapped in the ¼-in. pipe and fittings. Five readings of the differential gages were taken for each test which was [illegible] by the required time between initial and final readings of the weighing tank. The average of these five readings was employed in the calculations. Two tests were made for each [illegible], the second in each case serving as a check.

Computations and Results.—The rate of discharge in a pipe for any test was obtained by dividing the quantity of water discharged by [illegible] (weight of a cubic foot of water) and the time in seconds. This rate of discharge divided by the cross-sectional area of the pipe in square feet gave the velocity in feet per second. The head lost [illegible] for the length of pipe under test was equal to the reading of the water differential gage directly and to that of the mercury differential gage when multiplied by [illegible]. For the convenience of ready comparison, the friction heads were reduced to the basis of head loss per 100 ft. of pipe.

In order to find the relation between loss of head and velocity, values of loss per 100 ft. of pipe were plotted against velocity in feet per second on logarithmic paper. This relationship was ascertained for the two conditions of flow—with and against laps. The graphs are straight lines, indicating that the relation of the logarithm of the velocity to that of the head lost is a constant. One noticeable fact is that the graphs are nearly parallel, thus showing that the slope varies but little for the different sizes of pipe. It was also shown that the loss decreases with increase in diameter for any given velocity, that the loss is greater for flow against than with laps, and that the difference of loss with and against laps decreases with increase of diameter. That the effect of direction of flow becomes correspondingly less as the size increases is to be expected since the thickness of the lap is a constant for the pipes tested and, therefore, the ratio of this thickness or projection to the diameter decreases with increase in diameter. Thus the large sizes approach the conditions of smooth pipe.

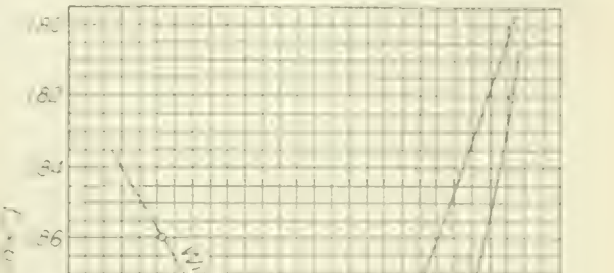


Fig. 2—Relation of n to d in the Equation n [illegible] ad [illegible] bd [illegible] cd [illegible]

Relation of Head to Velocity.—The equation of the graph showing the relation of head lost to velocity is readily determined, both analytically and graphically. The equation is of the form, $h_1 = m (v)^n$ where n is the tangent of the angle that the graph makes with the horizontal axis and m is the value of h_1 when v is one foot per second. Fig. 1 shows values of m plotted against pipe diameters, d, to determine whether or not a relationship existed between these two quantities. The graph proved to be a straight line when plotted on logarithmic paper, its equation being, $m = k (d)^x$ where x is the tangent of the angle that the graph makes with the abscissa and k is the value of m when d is 1 ft.

The graphs showing the relation between n and d were plotted on both logarithmic and rectilinear cross-section paper. The form of the latter (Fig. 3) suggested that a sine equation could be found to satisfy all points. Accordingly, given values of n and d were substituted in the equation n = a + b sin (cd + e) and the values of the constants a, b, c and e were found by solving the equations simultaneously. The equation thus obtained was carefully plotted and found to satisfy all points except that for the 6-in. pipe when the flow was directed against the laps. The limits of usefulness of the equation were found by determining the point of inflection when the second derivative of the equation was made equal to zero. The form of the graph if produced would be a wave, the values of the constants in the equation remaining true only between any high (the crest) and low (the trough) points. The points of inflection are the high and low points just mentioned. The equation for flow with laps holds good for all values of d = to 4 in. and greater and for all values of d when the flow is directed against the laps. The relations thus established furnish a means of computing m and n for any diameter of pipe. It has been customary to interpolate values of friction losses for a given size of pipe where experimental data have been lacking. The results thus obtained are approximate and not as trustworthy as those from the general equation after first establishing the values of m and n.

Coefficient of Friction. The coefficient of friction, f, in the equation, $h_1 = flv^2/d2g$, was found for the several sizes of pipe because this equation is the one in general use and the results obtained will correspond with common practice. Values of f were computed for half-foot increments of velocity up to 15 feet per second for the 4 and 6-in. pipes, up to 12.5 feet per second for the 8-in. pipe, and up to 9 feet per second for the 10-in. The method of obtaining these values was as follows: The value of h_1 for a given velocity was observed on the head lost-velocity graph. This value was then substituted in the equation, $f = h_1 d2g/lv^2$, and the equation solved for f. The relation of f to velocity was established on a large scale and a smooth graph drawn as a means. It is the opinion of the authors that the exponential equation is the proper one to use. The equation, $h_1 = flv^2/d2g$, defines the friction loss as varying with the square of the velocity while as a matter of fact the loss varies as some other power of the velocity than two.

It was found that the coefficient of friction, f, decreases in all cases with increase in the velocity. This relation is identical with that established for smooth pipes and will always hold true when n is less than two in the equation, $h_1 = m(v)^n$. It was also observed that for any given velocity, the coefficient of friction increases with diameter until the latter has a maximum value of 8 ins., when it begins to decrease. In the case of smooth pipes, the coefficient always decreases with diameter for any given velocity. The authors suggest the following as a possible explanation of this phenomenon: The water is of course in turbulent motion and its direction of flow may be as the twist and propulsion of a right hand screw. If this hypothesis be true, then the path of a particle of water will have a tendency to coincide with the spiral winding of the pipe. The friction loss would then be less than if the particles of water passed across the laps, there being a break or jump in the path at each lap. In other words, there will always be less loss of energy when any moving portion of matter moves with no sudden change in its direction of motion. The decrease in head lost due to spiral action must be greater than the effective resistance of the rivet heads. As the size of the pipe increases, the ratio of the amount of lap to the diameter diminishes and the condition of the interior wall approaches that of a smooth pipe, although that loss in the former will be greater because of the projection of the rivets.

Conclusions. The friction loss in galvanized spiral riveted steel pipes when the flow is with the laps does not differ greatly from that in new smooth cast iron pipes.

Spiral pipe should be laid so that the flow is with the laps.

The friction loss may be expressed as $h_1 = m(V)^n$, where h_1 is the loss due to friction expressed as head in feet of water, v is the mean velocity in feet per second, and m and n are constants for any given diameter of pipe.

The constants m and n for [illegible] diameters are readily established, permitting the probable friction loss to be calculated for any size of spiral pipe when experimental data are not available.

Methods and Cost of Repairing a Stand Pipe

During a heavy gale on Dec. 14, 1917, a section of a standpipe of the Bath Water District of Bath, Me., failed. The structure was built in 1887. It has a mean interior diameter of about 34 ft. and a clear interior height of 74 ft. All rings are 5 ft. in height, with lapped vertical and horizontal joints, the horizontal joints on the lower side of the bottom sheet being double riveted, all other horizontal joints single riveted, and all vertical joints double riveted. The upper top of ring was reinforced by a 3-in. angle iron made up by a series of short lengths. The section that failed was on the easterly side of the standpipe and extended down about 35 ft. from the top. The lower limit of the damaged section was at the level of the water in the standpipe at that time.

The methods of repairing the standpipe were described by Clarence E. Carter and Walter F. Abbott in a paper presented at the last annual meeting of the New England Waterworks Association.

The standpipe was operated with the remaining available depth of 40 ft. until the latter part of the summer of 1919, when the Water District contracted with the Bath Iron Works, of Bath, Me., for its repair and restoration to full capacity.

For the prosecution of this work, the contractors installed at the site a portable boiler, to supply power for the steam hoists which handled the plates, and an air compressor for riveting. A staging was erected on the outside of the standpipe and a float placed on the inside.

Each plate was carefully marked, the rivets "busted" off with hand hammers, and the plate lowered to the ground. The plates were then hauled by trucks to the local plant of the contractors, re-rolled to original shape, and then replaced in the structure. In all, 27 plates were removed, 24 being re-rolled and 3 new ones furnished; those which came at the lower extremity of the damaged section being broken so that they could not be repaired.

In re-setting the plates, each ring was completed, and then the water level in the standpipe was raised sufficiently to bring the inside float to the proper working level for placing the next ring. Control of the level of the water in the tank was maintained by means of temporary telephone connections with the superintendent's office, and the superintendent in turn regulated his pumps to produce the desired result. After all of the plates had been replaced, the top of the upper ring was reinforced by a 6 x 6 x ⅜ in. angle iron in 18 ft. lengths, and four steel wire guys (1 in. in diameter) were fastened to the quarter points of the top and anchored to the ledge about 100 ft. from the base of the standpipe.

As the bottom needed some attention and the paint needed renewal, the water was drawn out and about 1 ft. depth of concrete was placed over the entire bottom, and the structure was given two good coats on the inside and one on the outside of Detroit graphite paint.

The time consumed in making all repairs is divided as follows:

	Days
Repairs to the plates	41
Concreting the bottom	2
Painting	1½
Total	44½

The structure was entirely out of service during the concreting and painting only a period of six days, and during this time water was pumped directly into the distribution system, which was protected by two relief valves, one being at the Nequasset Pumping Station, which is about 2¼ miles east of the city or 3¾ miles east of the standpipe, and the other being at the Thompson's Pumping Station, which is about 2 miles west of the standpipe.

The cost of the work was as follows:

Repairing the plates	$5,408.81
Additional braces and [illegible]	1,437.82
Painting	291.63
Total	$7,138.26

The total cost, for repairs only, is an average of $215 per year since the construction of the tank—the painting cost about 11½ ct. per square yard per coat, but this cost excludes some additional expense which would have been encountered had the painting been done at some other time as an entirely separate job.

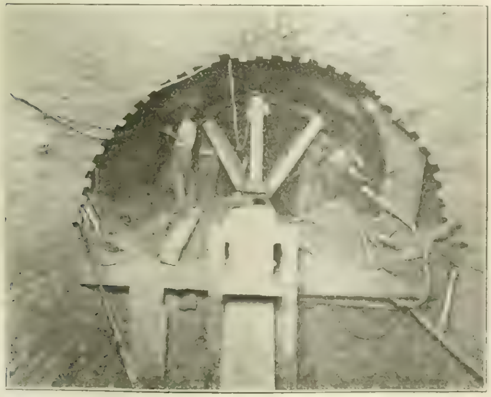
Driving Sewer Tunnel at Detroit with Pneumatic Spaders

Pneumatic spading tools are being used with much success in driving the tunnel for the Jos. Campau and Palmer Ave. sewer at Detroit, Mich. This sewer, in general, is 10½ ft. inside diameter with 18 in. of brick work all around. The actual excavation is for a tunnel 14 ft. in diameter.

The brick work closely follows the excavation, the tunnelling being done in the day time and the masonry being laid at night. The brick laying gang finishes its work at 3 a. m. Two miners, with the pneumatic spaders, then start driving a monkey heading 2 ft. wide, 3 ft. high and 14 ft. long, for a needle beam which serves the double purpose of a base for bracing in bad ground and for the support of the arches for the overhead masonry.

Tunnel in Good Ground 47 Ft. Below Surface. At the Time the Photograph Was Taken an Advance of 1,000 Ft. from the Shaft Had Been Made.

The day gang begins work at 7 a. m. With four miners (the hammer men), four muckers, and one man to take off the cars, an average progress of 14 ft. of tunnel is driven per day. This means 14 ft. of finished sewers as the masons lay the brick for this portion at night. The miners are paid on a footage basis and some of them average as high as $14 per day.



Tunnel in Ground Requiring Bracing. This Is a View of the Sewer Being Driven in Other Direction from the Shaft.

With these tools the exhaust of the hammer supplies fresh air to the miners, a decided advantage when the tunnel is in 1,000 ft. or 1,200 ft. As a usual rule on this job, one shaft is put down and the tunnel driven both ways from it to meet the connecting links of the sewer.

The tunneling equipment on this work consists of a 12x10 Chicago pneumatic compressor, a 42x8 tank, and a 75 H.P. 50° General Electric motor, with drum control and oil switch. A 3-in. supply pipe is laid in the tunnel, flange unions being used so that the pipe can be taken readily from place to place. Chicago couplers and Chicago cord hose are also used in addition to the No. 0 Boyer clay diggers, 16 of which are on this job—10 in service constantly and 6 in reserve.

The contractor for the sewer is J. A. Mercier & Co., Penobscot Bldg., Detroit, Mich.

U. S. Chamber of Commerce to Work Out Plan for Land Reclamation

An intensive study of the whole subject of the reclamation of waste areas has been started by a special committee appointed by the Chamber of Commerce of the United States. It is the aim of the committee to work out a national plan for the reclamation of idle lands by irrigation, drainage, dikeage and other methods.

The committee will go into the social, political and economic questions involved in the subject, giving special consideration to such questions as the drift of the population to the cities, the effect opening up new territory has upon industry, and the practicability of this method of providing lands for war veterans.

The committee will consider the reclamation bills before Congress and will devote its attention to the broad principles of the entire subject. At the conclusion of its investigation, the committee will submit a report which can be made the basis for a referendum vote of the organization within the chamber's membership.

E. T. Meredith, former secretary of agriculture, of Des Moines, Ia., is chairman of the committee. The others members are: Hugh P. Baker, executive secretary, American Paper and Pulp Association, New York; E. F. Blaine, vice-president Seattle Chamber of Commerce, Seattle; Marshall N. Dana, Oregon Journal, Portland; Clyde C. Dawson, attorney, Dawson & Wright, Denver; W. E. Guild, treasurer, Finkbine Lumber Co., Jackson, Miss.; E. D. Holmes, president Chamber of Commerce, Casper, Wyo.; Edwin L. Lobdell, Edwin L. Lobdell & Co., investment bankers, Chicago; Felix M. McWhirter, president Peoples State Bank of Indianapolis, Indianapolis; Frederick H. Newell, consulting engineer, U. S. Reclamation Service, Washington; Walter Parker, general manager Association of Commerce, New Orleans; J. H. Ross, president Exchange Supply Company, Tampa; R. E. Shepherd, general manager Twin Falls North Side Land & Water Co., Jerome, Idaho.

Effect of Meterage on Water Consumption

The following table is reprinted from the 16th annual report (for the year ending Sept. 1, 1921) of the Board of Water and Sewer Commissioners of New London, Conn.:

Year ending	Consumption	Gallons to each inhabitant.	Gallons to each consumer.	Per cent measured by meters
Sept. 1, 1911	1,047,421,000	144	151	35
Sept. 1, 1912	1,106,963,000	154	157	35
Sept. 1, 1913..	1,133,300,000	155	160	37
Sept. 1, 1914 .	1,090,055,172	149	154	40
Sept. 1, 1915.	991,599,764	131	126	42
Sept. 1, 1916	869,568,240	111	109	55
Sept. 1, 1917	903,876,850	111	104	71.5
Sept. 1, 1918..	1,115,177,740	127	99	58
Sept. 1, 1919	1,206,217,060	131	123	69.3
Sept. 1, 1920..	1,121,732,810	119	117	77
Sept. 1, 1921	969,032,844	110	107	100

The report contains the following comment on the result of meterage:

> Every service in the city with the exception of fire services and fire hydrants is now metered, and, as stated in the last annual report, the city of New London is 100 per cent metered. The effect of entire meter installation is shown by the total consumption table, and also the amount of water rates collected. It is now an established fact in this city that a metered service is the only equitable way of supplying water to consumers.

If all the fixtures and pipes in the buildings supplied are kept tight it is found that in a large per cent of cases the meter is a money saver to the consumer and a water saver for the department. If the meter is found to be registering a larger consumption from the last reading, the meter reader notifies the office, which in turn notifies the owner. In this manner the owner is notified of a large consumption and it remains with him to reduce this large consumption by repairing leaking fixtures or by using less water. But few cases of excessive consumption were noted during the year and the few that occurred were due to leaks which were not given immediate attention after the owners had been notified of the same.

Treatment of Storm Water

[illegible] thing, [illegible]

[illegible]

[illegible] so that insufficient [illegible]

[illegible] effluent.

[illegible] treatment plant [illegible] ble, at convenient [illegible] on the theory that, [illegible]

[illegible] m the watershed that the accession [illegible]

[illegible] its will occur, the [illegible] material forming bars and the floating portions be- [illegible] and littering the shores.

[illegible] of drought, when a sudden shower causes [illegible] eam, the first flush car- [illegible] accompanied [illegible] by a greater dilution of rain water.

Treatment for Storm Water.—[illegible] pended solids often may [illegible] ous offense, or be carried on by the [illegible] in other grosser deposit-forming materials. The treatment, indicated for storm-water, [illegible] and heavy detritus before the effluent is admitted to the stream.

[illegible] gravel, bones, fruit pits, tin cans, rubber, leather, and objects in part made [illegible] in a current of 1 ft. per [illegible] excluded by racks, the [illegible] mainly grit, ashes, sand, and gravel.

[illegible] rinds, remains of fireworks, rubber and baseballs, and toys [illegible] If racks are provided they will [illegible] t mentioned, a collection [illegible] sly.

[illegible] be classified [illegible] ks with bars from 3 to 4 [illegible]

Features of Detritus Plant.—If the proposed detritus plant [illegible] attendance is [illegible] will occupy [illegible] If the [illegible]

[illegible] of from [illegible]

[illegible]

[illegible] velocity. The grit may be excavated by a clam-shell bucket, removed in trucks or cars, and used for filling.

The finer screenings may be handled in various ways. When at or near a sewage disposal plant, mechanical screens may be used. At the lower end of a grit chamber, 10 or 12 ft. wide carrying about 40,000,000 gal. per day, a 12 ft. R.-W. screen, or a 12 ft. Dorrco screen 10 ft. long may be used if properly housed and provided with power.

Another method would be to construct the grit chamber on a bank with the upper part of the side next to the stream of some permeable material so that water may pass through, retaining the screenings deposited on its surface. Maintaining a proper velocity through the chamber and keeping the porous bank from clogging would be the chief difficulties with this design.

Another suggestion which has considerable promise, is a grit chamber preceded by coarse racks and provided at intervals of about 25 ft. with several sets of inclined scum boards continued downward with inclined racks, progressively finer down stream, each of which is provided with raking platforms above and short submerged platforms projecting up stream from their lower ends to retain the screenings. These racks will not reach the bottom of the chamber, but will stop about 4 ft. above it. The down-stream end of the chamber will consist of an overflow weir which will maintain the water in the channel at the desired elevation. A drain valve for re-watering will also be provided.

All such devices will require periodic attention and cleaning and cannot be operated satisfactorily except on a methodical schedule, directed by a responsible man.

Details of Structures for Treating Storm Water.—As previously mentioned, structures for treating storm-water may be made up conveniently of units about 10 or 12 ft. wide by a maximum of 10 ft. deep and from 60 ft. to 120 ft. long, designed for a velocity of 1 ft. per second. The number of such units will depend on the quantity of storm-water anticipated, assuming the capacity of each channel to be 60 cu. ft. per second. Either there must be a sufficient number of such units to carry the estimated maximum flow, or a smaller number may be constructed and a by-pass provided, as economy may dictate.

The simplest way of accommodating an extreme flow would be to construct the walls of the channels with considerable freeboard, in order that an increased head on the outlet weir would accommodate the increased discharge.

Computating Run-off to Be Provided for at Outfall.—As an example of about what would be required, let us assume a water-shed of 1,000 acres, 1 mile wide and nearly 2 miles long, with the longest sewer 12,000 ft. in length from source to outfall, and with grades such that when running full, the velocity will average 5 ft. per second. It will require, therefore, 40 minutes for water to travel down the entire system, and if a period of 5 minutes is allowed for the water to reach the sewer, a shower of 45 minutes' duration will be the shortest in which the entire water-shed will contribute and precipitation from the remotest corner of the territory reach the outfall at the same time as from every other part. If from an examination of the rainfall records of the locality, we select the 45-minutes shower of such intensity that it occurs every year or two, it may be used as a basis for the computation of the run-off to be provided for at the outfall.

In Rochester, N. Y., this 45-minute shower has a rate of 1.22 in. per hour. In the residence section about 25 per cent of the precipitation from these violent showers reaches the sewers during the period. A discharge of 1,000 × 1.22 × 0.25 = 305 cu. ft. per second, therefore, can be computed which will require five of the grit-chamber units mentioned. Such a plant will take the discharge of a 9-ft. sewer at a grade of 1 in 1,000, or a 7-ft. sewer at a grade of 1 in 280.

This may be roughly stated as three of the previously mentioned detritus chamber units per square mile of tributary territory, subject, however, to wide variation, depending on the rainfall, the slope, and the character of the territory. A similar approximation would place the cost of construction of such a detritus plant at from $10,000 to $12,000 per square mile of territory.

It is appreciated that to date little has been done in storm-water treatment and that the health authorities have been interested chiefly in the protection of streams from other pollution, but the time may be anticipated when the concentrated storm water discharge of cities will demand attention

Automatic Hydro-Electric Generating Stations

Millions of horsepower of hydroelectric energy throughout the country remain to be developed. Some of this energy will be obtained from large projects, but for every Niagara or Keokuk there are hundreds of possible small developments, individually of small consequence, but important in the aggregate. However, for a plant developing, say, 300 or 400 kw. the wages of even a single attendant on each shift amounts to a material increase in the unit cost of energy, and this has, prior to the development of the semi-automatic and fully automatic station, interfered seriously with the construction of such small plants. A further disadvantage of the small manually-operated station is that the companies operating such stations have not felt justified in employing skilled engineers to control and operate them. On the other hand, it is economically feasible for the control of automatic stations to be in skilled hands. "Thus," in the words of Charles P. Steinmetz, "the automatic hydroelectric station is not merely an advance in economy, which makes the operation of small stations possible, stations which were previously below the economical limit, but it is an equal advance in the safety and reliability of the operation of these stations, and therewith of the systems into which these stations connect."

An interesting account of some California automatic stations is given by Dorville Libby, Jr., in the January issue of The Tech Engineering News, from which the matter following is taken.

In the development of such stations, the remote-controlled or semi-automatic type naturally came first. In this type the generator leads run to the main station, where the generator is synchronized by hand, whereas in the fully automatic station the generator is automatically synchronized into the transmission net-work.

Ontario Power Co. Stations.—One of the pioneer semi-automatic stations is Ontario Plant No. 2 of the Ontario Power Co., situated in San Antonio Canyon, near Ontario, Calif.

The profile of this stream is composed mainly of rapids and falls, alternating with long stretches where the fall is relatively slight, a condition particularly favorable to the construction of several plants supplied by short conduits, rather than attempting to develop all the available power at one point. The first development was at Plant No. 1, a manually operated station. Plant No. 2 is situated about 3½ miles upstream from Plant No. 1, the attendant at No. 1 operating the controlling devices for No. 2. Plant No. 3, downstream from Plant No. 1, is now under construction and is to be entirely automatic. No storage is available at either of the three plants. The capacity of each plant is about 20 second-feet, the flow at each plant being approximately the same. This capacity is exceeded during flood periods only. For five months of the year the stream flow may be expected to be 20 second-feet. For three months a flow ranging from 17 down to 11 second-feet is probable, while during the low-water period of the summer and early fall, the flow is about 8 second-feet.

Remote Controlled Power Station.—The water supply for Plant No. 2 is diverted from the stream, which flows in two branches at this point, by two small dams. From the point of diversion it is carried 3,280 ft. in a cement pipe line, 30 in. in diameter, and laid on a grade of about 1 ft. in 400. A tank 10 by 12 by 12 ft. serves as a forebay. From the forebay a 24-in. riveted steel penstock 1,413 ft. long delivers the water to the power house. The gross head is approximately 310 ft. and the net effective head about 290 ft.

The principal equipment comprises a Pelton single overhung impulse turbine rated at 550 HP. for a head of 290 ft., and a Westinghouse 500-KVA, 50 cycle generator, with a direct-connected exciter. Water is supplied through a duplex nozzle, and a third nozzle is provided to use as a bypass in case the plant is shut down. All three nozzles are operated by electric motors provided with limit switches interlocking in order to maintain fixed relative action between the three, and thus obtain the maximum possible efficiency at all degrees of load and water consumption.

Speed regulation because of minor variations in load and the necessity for maintaining a continuous stream flow is provided for by means of jet deflectors. These deflectors divert any required fraction of the water from striking the buckets of the wheel, and, being actuated by the governor, respond instantly to changes in speed of the wheel.

How the Semi-Automatic Plant Is Controlled.—Plant No. 2 is controlled from Plant No. 1 by means of a double throw switch. When the plant is operating on full load, both power nozzles are full open and the by-pass nozzle is closed. If it is desired to reject all of the load, the duplex switch in Plant No. 1 is thrown to the "To Close" position, and the first action is to close the relay, which starts the closing of the upper power nozzle. After a certain predetermined interval a contact switch on the upper nozzle acts to close a relay, which starts the closing of the lower power nozzle. Then for a certain interval both nozzles are closing together. On reaching a certain point of closing, which corresponds to a predetermined minimum stream flow, a contact switch on the lower nozzle acts to close a relay, which affects the opening of the by-pass nozzle. Then for a short interval both power nozzles are closing and the by-pass nozzle is opening.

Interior View of Semi-Automatic Station.

The upper nozzle, which starts to close first, reaches the full closed position first, and its limit switch acts to open its closing relay to prevent jamming of the mechanism. By the time the lower power nozzle reaches its full closed position the by-pass nozzle is opened to the predetermined point which discharges the required flow, and the limit switch on the lower nozzle acts to open all relays and stop all action. Water than flows through the by-pass only and the generator is unloaded and removed from the line.

When it is desired to put the plant onto the line, the duplex switch in Plant No. 1 is thrown to the "To Open" position and the sequence of operations is started, but in the reverse order, thus:

1. By-pass closes and lower power nozzle opens.

2. Upper power nozzle opens with by-pass still closing, and lower power nozzle opening.

3. By-pass nozzle reaches full closed position with both power nozzles still opening.

4. Lower power nozzle reaches full open position and its limit switch acts to stop all action, both power nozzles being open and the by-pass nozzle closed.

The operation of the plant is not limited only to the full on or off positions, as any position between may be reached and held by the manipulation of the central switch in Plant No. 1. This is a necessary provision to permit the synchronizing of Plant No. 2 with Plant No. 1, and to regulate for different loads or stream flows.

Synchronizing is accomplished altogether by the remote control of the power nozzles, the synchronoscope and main generator switch being on the panel with the nozzle control switch in Plant No. 1. A Tirrill regulator is installed at Plant No. 2 to effect voltage regulation in the normal way through the exciter field.

Except during flood periods, all the flow of the stream passes through the penstock at Plant No. 2. The water consumption is governed by the water level in the forebay, whic his read by the station attendant at Plant No. 1 from [illegible] a flash-board [illegible] the water [illegible] to bring the water [illegible] at a [illegible] point.

[illegible] A [illegible] the [illegible] Plant No. 2 is [illegible] than the [illegible] at Plant No. 1, so that it will operate only in case of line trouble between the two plants. [illegible] visits are made to Plant No. 2 for inspection, oiling and adjustment of the equipment.

An Automatic Station.—The plant was placed in operation during the summer of 1919 and the results have been so satisfactory to the power company that, as mentioned above, [illegible] Plant No. 3, which is to be entirely automatic. The hydraulic turbine for the new plant is being built by the Pelton Water Wheel Co., manufacturer of the turbine for Plant No. 2 and is similar to that unit. It will be direct connected to a 400 KVA General Electric Co. generator, with direct connected exciter.

The generator will go on the line and be synchronized [illegible] automatically. The plant will shut down automatically in case of heating of bearings, over-voltage, low-voltage or other mishaps.

In conclusion it might be said that in designing automatic stations a number of considerations of importance in the manually operated station do not apply. For instance it is very desirable that the operator of the manual station be able to see from one point, not only the indicators, but all the machinery as well. In the automatic station, on the other hand, it is not necessary to sacrifice other considerations in order to prevent one piece of apparatus from obscuring the view of another piece. Various provisions for the comfort of the operators are also unnecessary. Again, take the question of architecture: the automatic station will [illegible] be situated in some isolated place, where it will be seen by few people except the company's patrolmen. For this reason the exterior design may often be severely utilitarian.

Treatment of Swimming Pool Water with Ultra Violet Rays

Results of an investigation of the treatment of swimming pool water with ultra violet rays are given in the November issue of The Health, a publication of the Health Department of Detroit, Mich., by Warren F. Walker, Deputy Commissioner of the Department. The investigation was made this year of the operation of a well built and carefully operated swimming pool of [illegible] gal. capacity in Detroit, with treatment plant of pressure filters and ultra violet ray sterilizer. Water was supplied at the rate of 7,000 gal. per hour in the three-week periods under investigation, using (1) filtered water, with displaced water run to waste, (2) filtered and sterilized water, with displaced water run to waste, and then (3) filtered and sterilized water by recirculating the pool water through the treatment plant. The conclusions are (1) that a high turnover rate and uniform distribution around the pool are most desirable features in swimming pool treatment; (2) that the bacteriological standard is the only one upon which we may safely judge the condition of a pool and any method of treatment employed should be frequently checked by bacteriological examinations of the pool; (3) that the supplying of a large amount of water to a well designed pool in large quantities will give a fair bacteriological result; (4) that treatment by ultra violet rays of recirculating pool water, if properly operated, gives a water in the pool which compares favorably with the treasury standard for drinking water. In Mr. Walker's opinion, the results give further evidence that the effect of ultra violet rays on the bacteria in water is not confined to the short interval during which it is exposed to the direct rays, [illegible] the absorption of the [illegible] energy by the water tends to mildly [illegible].

Pumping Plants for Drainage Systems*

By L. C. CRAIG,

[illegible] Perkins Engineering [illegible]

Of the many acres of swamp and overflowed lands in the United States a large percentage is so situated that it cannot be entirely reclaimed without pumping. This is especially true of the 20,000,000 or more acres in the Mississippi River Valley.

The drainage of these lands has been largely a development of the last 25 years. During this period many drainage districts have been formed in the Mississippi River Valley, the first areas to be reclaimed being those so situated that all or a part of the drainage water would flow off by gravity. Gradually as the land increased in value pumping plants began to be installed more and more, as a part of the drainage systems. There exist today many areas with no drainage and others where only partial gravity drainage is obtained, where eventually pumping plants will be installed.

Only a few years ago $20 to $30 an acre was considered a big price to pay for the draining of agricultural land. Today, because of increased land value, many areas are being reclaimed at a cost of $60 and more an acre.

Unfortunately, there exist today few reliable records concerning the capacity and efficiency of drainage pumping plants. Such records, where found, usually extend back over a period of only a few years.

Many plants have been installed without adequate means being provided for making tests, or those in authority have failed to realize the necessity of such tests. In many cases no engineer is employed after the construction period.

Those matters are gradually being remedied and during the next few years we will see a very marked development of drainage pumping in this country.

A drainage area requiring pumping is usually one with the ground level, so low as to require the raising of the drainage waters over a dam or embankment to a higher level. This dam or embankment may be part of a levee system, constructed to protect lands from flood overflow, as is the case in most river bottom areas, or a dam and pumping plant may be placed in an ordinary drainage ditch at a point where, because of a very flat gradient or lack of outlet, it is found impossible to take care of the drainage waters by ordinary ditch construction.

Factors in Design of Pumping Plant.—The size of pumping plant required for any particular drainage area depends upon a number of varying conditions, among which are:

1. The size and topography of the drainage area.
2. The amount and distribution of rainfall.
3. The system of ditches and drains used, and the amount of storage capacity available in ditches and reservoirs.
4. The nature of the soil and sub-soil as affecting run-off and seepage.
5. The method of operation of the plant and the degree of drainage required.

The first three factors given above are, of course, the most important in the design of any drainage pumping plant, but all should receive consideration

For the past 20 years, or more, in Central Illinois and along the Mississippi River pumping plants for removing water from flat drainage areas have been designed for a maximum pumping capacity sufficient to remove in 24 hours ¼ in. in depth of water over the entire area. In Holland and other European countries for a much longer period ¼ in. or a little more has been used as the maximum capacity for drainage pumping plants. Experience in recent years has not shown that the run-off coefficient of ¼ in. should be changed as a standard basis of design under average conditions. But the engineer must be sure to give due consideration to all modifying conditions in each particular case.

All other conditions being equal, the small drainage area of only 1,000 or 2,000 acres will require a slightly larger pumping plant in proportion to its size than an area several times as large. Where some of the area is higher with steep slopes and impervious soil, the run-off coefficient for this portion must be made greater, in some cases it will be twice as great

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*Paper presented at the annual convention of the National Drainage Congress, held at St. Paul, Minn., Sept. 22-24.

The amount of rainfall in Central Illinois averages about 35 in. per year. Of this amount measurements have shown that about 26 to 30 per cent appears as run-off. Rains of 2 to 3 in. in 24 hours occur occasionally and rains of 4 in. in 36 to 48 hours sometimes occur.

In many drainage areas considerable storage exists in lakes and sloughs which it may not be found desirable to drain. This storage capacity, in addition to the storage ordinarily afforded by the drainage ditches, will reduce the size of the required pumping plant. If there exists considerable areas of tiled land, additional storage will be afforded.

Influence of Soil and Sub-Soil on Run-off.—The nature of the soil and sub-soil of the drainage area has a big effect on the run-off, and when the water on the outside of the levees, in the case of a levee district, is at a high stage, on the amount of seepage. If the soil is a close, compact formation, the surface run-off will be heavier from a sudden rain. A sandy sub-soil underlying a drainage area is generally an advantage, because the necessity of constructing tile drains and many small lateral drainage ditches may be largely eliminated, but during high water on the outside of the levees the effect may be the opposite, and the amount of pumping increased by an excessive amount of seepage.

Levees exceeding 10 ft. in height are usually constructed with a muck ditch or small ditch excavation 4 to 8 ft. in depth, constructed under the base before the levee is built, so as to bind in and help consolidate the levee fill with the soil formation underlying the base, and levees, when so built, have been found to resist seepage in a marked degree. However, even with a well-built levee and a sand or gravel subsoil there will be a considerable amount of seepage which rises to the surface of the ground inside the levee or may be intercepted by tile drain or surface ditches. Where such tile drain or surface ditches exist, located parallel to and adjacent to a levee so as to cut off and carry away the seepage, the amount of such seepage waters may be as much as 2 second feet per mile of levee.

The Pumping Plant.—A pumping plant should be designed to operate continuously if necessary. Generally, during the winter months little pumping will be necessary, because without growing crops little drainage will be needed, but it will be found to be an advantage to pump occasionally throughout the winter so as to reduce the ground water level and thereby secure an early drying of the soil in the spring. In this manner the run-off from heavy rain coming in the spring will be lessened and the size of the pumping plant which might otherwise be required may be reduced.

After the amount of water to be provided for in the capacity of the plant has been decided on, we must next determine the type of engine and pump which should be used.

The importance of a well designed pumping plant cannot be overestimated. Many pumping plants have been installed in drainage districts along the Mississippi and Illinois Rivers which have been operating with very poor economy, because of poor design. In some cases both pumps and engines have been removed and others installed once or more in a period of 10 or 15 years.

A well designed pumping plant does not mean necessarily one having the greatest economy of operation. Usually from 60 to 80 per cent of all pumping is done in the four months, March, April, May and June, and during the late summer and fall months in some localities no pumping at all is needed. It can readily be seen, therefore, that with the plant idle a good share of the time it might not be economical to spend a lot of money on costly equipment in order to secure economy of operation.

As a usual thing, in a well designed pumping plant using steam, the operating expenses are about half of the total cost, including the fixed charges. Where the operating expenses are much less than half of the total cost it will usually be found that the total cost should be reduced by using less costly equipment. The item of fixed charges, including interest, taxes, insurance and depreciation, should always be given full consideration in arriving at the total costs as in any other well designed plant installation.

The Pumps.—As pumping plants must be depended upon to operate when needed, and any delay may mean a flooding of large areas with resulting loss of crops, reliability is one of the chief factors governing design. Or, as a usual thing, it may be said that a type of pumping plant which has proved itself reliable and will require the least annual cost, including fixed charges, will be the best.

Several kinds of pumps, including scoop wheels for low lifts, rotary, plunger and centrifugal pumps, are used in drainage pumping, but the centrifugal pump has come to be recognized as best suited to conditions usually found in drainage work.

The number and size of the units to be used will, of course, depend upon the capacity and the conditions of operation. In order to have at least one pump in reserve in case of breakdown it is desirable to have at least two units, and one of these units should have about twice the capacity of the other, for the reason that the small unit will operate over longer periods with greater economy. This is especially desirable where steam is used as the source of power, as the frequent starting and stopping and firing up of boilers will necessitate the burning of much additional fuel, and shorten the life of the boilers. Where three or more units are used they should be of equal size. The total capacity of the pumps should be sufficient to pump the maximum quantity of water against a static head about 3 or 4 ft. below the maximum expected.

In order to determine the actual or hydraulic head on the pump, we must add to the static head an amount which should not exceed 3 ft. in a well designed pumping plant. This additional head, called the friction head, is due to the friction in suction and discharge pipes, the velocity head and the losses at the entrance and outlet of these pipes.

In many poorly designed plants not enough attention has been paid to eliminating the losses in the suction and discharge pipes. The entrance to the suction pipe should be expanded so as to reduce the velocity to not more than 3 ft. per second; 2 ft. per second is better.

The centrifugal pump operates efficiently only when running at or near the speed which is suitable for each particular head. Therefore, where the total head is variable, as in most drainage pumping, it is desirable to have some method of regulating the speed. This is accomplished in the case of the steam engine by regulating the speed of the engine and in the case of the constant speed induction motor by belt connecting to the pump and using two or more sets of pulleys so as to secure the desirable speed. This latter method is cumbersome and undesirable and there is the further objection of loss of power with the belt drive.

With a pump properly designed it may be found that the source of power can be direct connected to the pump and any loss in efficiency in the pump due to the operation at constant speed will be offset by the elimination of the power loss with the belt drive. With variable speed drive or with the steam engine or internal combustion engine direct connected, it may be found that there will be losses in the engine itself, due to operation at less or more than rated speed, which will make changes of speed inadvisable. It is necessary, therefore, that the engineer, before designing a pumping plant, should make a thorough study of all data concerning the equipment he proposes to use, and if possible he should examine other plants where reliable tests have been made.

Pump manufacturers will usually furnish characteristic curves showing capacity, brake horse power and guaranteed efficiency at various speeds. Curves should be drawn or computations made showing complete operating conditions, including the total quantity of water and the total number of horse power hours for various heads over a typical operating period of one year. These curves or computations should be compared with the characteristic curves of the pump to see that the pump has sufficient capacity and is so designed as to have a good efficiency while pumping the greatest quantity of water. From these data also the maximum horse power of the prime mover and amount and distribution of the fuel consumption can readily be determined.

In the case of variable speed drive a proposed operating chart should be made up, showing the proper speed and other operating conditions which should be used to secure greatest economy. The chart, of course, will be modified as found necessary by tests of the plant after construction.

Prime Movers for Drainage Pumping.—Steam engines, electric motors and internal combustion engines are all used as prime movers for drainage pumping. Which should be used, in any locality, depends upon the size of the plant, its method of operation, the cost of fuel delivered, and the availability of competent labor.

In locations where soft coal can be obtained cheaply, steam may be an economical source of power. In large units one [illegible] of steam is that better speed [illegible] pumps can be obtained. A disadvantage [illegible] in the intermittent operation of the plant previously [illegible] and difficulty in delivering coal and supplies. In plants of over [illegible] it will usually pay to put in high speed [illegible] with water tube boilers. Higher [illegible] such as the so-called "uniflow engine" with [illegible] are found suitable only for plants of over [illegible] where the cost of operation is a much larger portion of the total cost than in a small plant.

[illegible] has many advantages over other types [illegible] electric current can be supplied at a reasonable rate. The two principal advantages are low first cost and [illegible] of operation. Usually, the cost of an electric [illegible] pumping plant will be about 60 per cent of the cost of a steam plant. Its depreciation is much less than any other form of plant. It can be operated with ordinary labor with few repairs and in small plants its operation can be made automatic. The tendency during the last few years has been toward electric pumping.

Because of the low cost of fuel oil the internal combustion engine of the Diesel or semi-Diesel type is now receiving a great deal of attention as a source of power for drainage pumping plants. Up to about five or six years ago there were not over 6 concerns in this country building engines of the Diesel or semi-Diesel types. Now there are at least 16 builders of Diesel engines and at least 30 or more firms building various types of semi-Diesel or low compression engines.

Many of the types of internal combustion engines now being placed on the market are still in a state of development or have but recently passed that stage, therefore, before selecting this type of engine for a drainage pumping plant, the engineer should make a thorough investigation of the performance of engines which have been in operation at least two years.

The full Diesel is an engine using high compression and high temperatures with complicated valve mechanisms, needing an intelligent, skilled operator. Its first cost is also very high and although very economical in fuel consumption, its use for drainage pumping is practically limited to large plants.

The semi-Diesel or low compression engine offers better possibilities, I believe, for the small plant. This engine will develop a brake horse power hour on about 0.7 pint of fuel oil as compared with about 0.5 pint for the Diesel engine. At present prices, oil of the grade required for these engines can be delivered in most any locality at a cost of from 3 to 4 ct. per gallon. The first cost of these engines at the present time is about $50 to $60 per horse power, about half the cost of the Diesel engine in small units.

There are various grades of oil used in engines of this type, varying from a gravity test of 20 to 44° Baume. The trade name fuel oil, is applied to all oil residue left after distillation has removed the gasoline, kerosene and light distillates from crude oil and varies in gravity from 20 to 32° Baume. As oil varies in price, the lighter oils costing more, it is very important to be sure that the engine will run successfully on a low grade oil. Some manufacturers will guarantee operation on oil of a gravity of 24° Baume; others will specify a higher grade. In some cases where the low grade oil is specified there must be a very low content of sulphur or coke [illegible] or some other qualification which may raise the cost of the oil.

I recently had occasion to investigate the quality of fuel oil [illegible] used by a number of operators of semi-Diesel engines [illegible] and found that none of them were using the low grade guaranteed by the manufacturer. The cost of the oil being used exceeded the cost of the low grade oil by from [illegible] ct. per gallon.

[illegible] of a drainage pumping plant the engine must operate [illegible] at varying loads and the regulation of fuel and water supply must be entirely automatic. Some semi-Diesel engines have trouble with their fuel and water [illegible] and this is a matter that requires careful investigation.

With the increasing consumption of [illegible] it is fair to assume that there will always be a good supply of fuel oil [illegible] competition with coal or electricity. [illegible] Diesel engines and producing electric current at a cost, including all fixed charges, of 2 to 2½ ct. per kilowatt hour.

In conclusion, with reference to the use of the Diesel or semi-Diesel engine for drainage pumping plants, I will say that the development of this form of prime mover for stationary engines has not yet reached a stage where their use can be recommended without very careful investigation of plants now in operation, but I recommend that every engineer, before designing a pumping plant, investigate carefully the possibilities of this type of prime mover.

No Unsolvable Technical Difficulties in Providing Coal Storage Reservoirs

That there are no unsolvable technical difficulties in the way of the plan recently suggested by President Harding to the American Mining Congress whereby the production of coal might be made more uniform, and conditions of unemployment ameliorated and seasonal periods of depression largely obviated in the mining industry by the provision of storage reservoirs in which coal could be stored in quantity by large consumers and producers, is declared by Dr. H. Foster Bain, director of the Bureau of Mines. Careful analysis may show an extremely slight loss in the heating value of most bituminous coal after storage for a considerable period, says Dr. Bain. This loss, however, is very much smaller than is commonly supposed by the public, and in burning the coal little or no difference can be distinguished. Certain coals have an extra market value when carefully sized; handling these coals in and out of storage causes some breakage and may lower slightly the market value of particular coals, but this loss in value relates largely to the availability of the coal for certain classes of equipment and for certain uses, rather than to its actual heating value.

Spontaneous combustion in coal, the most troublesome factor in handling large storage piles, can be prevented, if proper methods of storage and supervision are adopted.

"The adoption of a general policy which would provide reservoirs of bituminous coal to be drawn upon in times of great demand or of low production is entirely a commercial question," continues Dr. Bain. "If the producer, or the dealer, or the large consumer, could produce or buy coal in the spring or summer for a price low enough to justify the cost of putting coal in storage and its rehandling, minus a fair insurance rate that he would be guaranteed a continuous supply in time of need, storage would become common."

"This lower seasonal price of coal could be brought about by concessions on the part of the miner, the mine operator, and the railroads. For the sake of obtaining more regular employment, the miner might accept a lower wage or rate in certain seasons of the year, although this is doubtful; but the mine operator might accept less profit during the same periods in order to keep up his production. Steady and regular mine operation at capacity production always means lower production costs, as compared with intermittent operation and lessened production. Overhead expenses—taxes, interest, management, together with the expense of keeping the mine in proper working condition—all go on, whether production is light, heavy, or has entirely stopped. The railroads could assist by accepting a lower freight rate on coal moved in the spring and summer.

"The small individual consumer, especially in the cities, often has inadequate storage space. Storage at the mine may allow a steady working day in time of shortage of cars but will not ensure steady seasonal operation. Again, large scale storage at the mines does not do away with the difficulty of transportation often experienced to the points of consumption. Moreover, a great many mines are in a hilly or mountainous country, where but little, if any, space is available for large storage capacities. The proper place, therefore, for storage on a large scale is at or near points of consumption.

"This latter kind of storage involves the use of a large plot of ground, as coal stored 10 ft. high allows slightly less than 10,000 tons storage per acre. The purchase and installation of mechanical coal handling devices and systems would also be necessary. There are in existence numbers of American engineering and machinery concerns who have successfully designed and built many coal storage systems for public utilities and other corporations which at present store considerable quantities of coal.

Purification of Soft Colored Waters

Engineers engaged in water supply work are in substantial agreement that a drinking water, to satisfy critical modern consumers, should have an average color of not more than 10 parts per million on the platinum scale, and its maximum color should not exceed 15 parts. Supplies from ground sources and from many lakes and ponds conform to this standard, but most of the clearer surface waters possess a brownish coloration, well above the limit of 15 demanded by the modern consumer. In Massachusetts, according to the reports of the State Department of Health, practically all the ground-water supplies which are free from iron, have colors not exceeding 10, while of 86 surface supplies, 50 or 58 per cent have average colors in excess of this standard. An interesting outline of what is being done towards the betterment of these colored supplies was given by Robert Spurr Weston, Consulting Engineer, Boston, Mass., in a paper presented Nov. 17 in the American Society of Civil Engineers' Symposium on Water Supply and Water Purification. An abstract of the paper follows:

Decolorization by Storage.—Storage for months or years in good reservoirs effects a decolorization of water. In this, iron plays an important part in flocculating minute particles of suspended matter which constitute what is called color. Several examples of this were given by Ralph H. Stearns, which show reductions of from 4 to 69 per cent through storage. It is most often impracticable to store waters long enough to decolorize them sufficiently to compare them, with a reasonable degree of favor, with filtered water and the average ground water, and, for this reason, as well as further to safeguard the public health, many stored colored waters are filtered. This practice is usual abroad, and is coming into increasing favor here, as evidenced by the new purification plant at Hartford, Conn., and the plans for the additional supplies for New York City, and Providence, R. I. The first large filters were built at Cleveland, O., and Somerville, N. J., and the second one at Washington, D. C. The filters at Hartford are of the slow type, and although the color of the effluent will probably not average as low as 10 parts per million, a supply of reasonably good appearance is assured by this method. Of course, color removal by slow filters has been the subject of many discussions, and the statements made have rarely taken into account the physical and chemical nature of color.

Removal of Color by Filtration.—Most of the color in water is in the form of a colloidal suspension, that is, the particles are so fine and so dispersed in water that they remain in suspension and act like true solutions, except that the Tyndall ray and the ultra-miscroscope reveal them. These colloidal particles are not all alike. They possess electrical properties, and when electrolyzed some of the particles will migrate to the positive, some to the negative pole. A small part of the color is apparently in true solution and is not affected by the electric current. It is reasonable to believe that colored water from a large lake or reservoir will contain finer particles of color than a river water. This belief is supported by the higher color removal by sand filters supplied by river than by reservoir waters. A slow sand filter will remove one-third of the color, but when treating certain river waters such filters may remove more than one-half the color, although they are usually unable to remove more than one-fifth of the color from a stored water.

There are waters, therefore, which require chemical treatment prior to filtration. In nearly all such cases, sulphate of alumina with or without an alkali has been used. The dosing has been based on the appearance and alkalinity of the water, and the results, especially in small plants operating without laboratory control, leave much to be desired. Recently, George C. Whipple, has stated:

"The use of alum with short periods of coagulation and mechanical filtration of the ordinary type is, in my opinion, inappropriate to a soft colored Massachusetts surface water. * * * * The corrosion problem in our State is serious and must not be made more so by inappropriate chemical treatment."

The mechanical filter, per se, is an efficient device, and the remedy lies in better chemical treatment. If the waters could be treated more scientifically, the period of coagulation might be reduced and the rate of filtration increased. Better treatment, however, must await the application of modern chemical and physical theories to practice, and this will require much investigation and many trials before any rules can be written for the non-technical operator.

Chemical Treatment and Decolorization.—At the present time, sulphate of alumina is added until coagulation takes place, and, in most cases, soda is added to maintain an alkalinity of at least 7 parts per million in the water delivered to the mains. Frequently, this method fails. At some places, such as Warren, R. I., soda cannot be used at certain times of the year, and the alkalinity is maintained by the addition of calcium carbonate in the form of powdered chalk. If sulphate of alumina is added to excess, better decolorization will be obtained, but the treated water will corrode the distribution system. In the one case the soda has been added to the filtered water. At Wilmington, N. C., the water is first overdosed with alum, and after it has passed through the coagulating basin, it is dosed with enough soda or lime to insure a final alkalinity of 10. In these cases, both the optimum decolorization by sulphate of alumina and the inhibition of corrosive action is attained. At Exeter, N. H., it was impossible, even by adding sulphate of alumina to excess, to reduce the average color much below 20 parts per million. Apparently, the water contained a large quantity of positively charged coloring matter which was not affected by aluminum hydrate having the same charge. By pre-treating the water with 0.5 parts of chlorine per million, a condition was brought about under which treatment with a small dose of sulphate of alumina easily reduces the color below 10 parts per million.

Ordinarily, one believes that if an equivalent quantity of soda is added to a unit dose of sulphate of alumina, aluminum hydrate will be produced. Try this in some cases in practice, and what results—a re-solutión of the color. In some cases reduce the equivalent dose of soda to, say, one-half, and a good decolorization may result. These facts are known, but the principles on which they are based are not yet clear.

The Problem of After-Precipitation.—In at least four rapid filter plants supplying New England towns, some of the aluminum hydrate passes the filters in a colloidal form to coagulate later in the distribution system. This was the chief of the many objections which the late Hiram F. Mills raised against alum treatment. This fault is noticed even at plants with coagulating basins of relatively large capacities, although not so frequently as at plants where the chemicals are applied directly to the influents of pressure filters. The trouble occurs most frequently in cold weather when all chemical reactions are retarded.

From what has been said, it is obvious that water purification experts are trying to solve what is, perhaps, the most difficult water purification problem, without a knowledge of the factors which enter into it, and until they can elucidate these factors, the demonstration of the theories is impossible.

For guides, engineers have depended largely on the color and alkalinity determinations. What do these mean? Simply a measure of the intensity of the one and the combining power of the other. No regular determinations record the nature of the color, and although the brown of one water may appear to be similar to the brown of another, it is no sign that they will respond to the same treatment. Thorndike Saville showed how varied were the components of color in water. His experiments demonstrated the ultra-microscopic character of the "suspensoids" and "emulsoids," to use the modern terms, which make up the bulk of color in water, and that these carry electrostatic charges, positive or negative, depending on, and varying with, the water. Usually, the color particles have a negative charge.

It is obvious that the difficulty of finding the charge of the color particles and the necessary treatment is not much facilitated by the ordinary water analysis. In practice, it is assumed that the color carries a negative charge, and aluminum hydrate is used with its positive charge, to neutralize and coagulate it. This treatment does not dispose of the positively charged color particles, except that these may be removed by the absorptive action of the precipitate produced by the negatively charged particles and the hydrate. Special treatment for these positively charged particles is necessary, and the substances added must not neutralize the effect of the positive aluminum hydrate. The good effect of chlorine at Exeter, and of carbon dioxide in the experiment of M. C. Whipple in increasing the electro-negative character of the color and, consequently, the decolorizing power of a given dose of sulphate of alumina, leads one to hope that methods for determining the electrostatic charges of color particles will come into more common use and their results will indicate more rational treatment than that commonly used at the present time.

The alkalinity determination simply expresses the quantity of sulphuric acid in terms of calcium carbonate required to neutralize the water. It does little else. Practically all the colored waters supplied to towns are alkaline. Yet, how different are the treatments required by waters of about the same alkalinity and color. An equivalent of magnesium hydrate has the same combining power as an equivalent of caustic soda. The former is called a weak, the latter a strong, alkali, and these adjectives describe their effects. By determining the hydrogen ion concentration, these differences of potency can be measured. This determination is coming into use; it has already been made part of the daily routine at Baltimore, Md., and other places. Apparently, there is an optimum hydrogen ion concentration for each water where coagulation is most nearly complete. It is not far from PH = 7.0. The hydrogen ion determination is not difficult, and the speaker believes that it may show what conditions of the dissolved salts in water, that is, the electrolytes, are most favorable for flocculation of the colloidal color, probably in many cases by suggesting treatment with other chemicals as well as with sulphate of alumina.

The problem, therefore, is to substitute a specific for a patent treatment by a more accurate analysis of color and a more proper dosage with chemicals, also by the creation of the most favorable condition in the solution—the water—for the flocculation and precipitation of the neutralized colloidal color. This seems to be complicated, but the speaker believes it will be worked out to a satisfactory solution in practice. Indeed, the collection and study of the more refined electrochemical data should explain the successes and failures in practice, and should help to rationalize the treatment of colored waters. On the practical side is the lure of a greatly reduced cost for chemicals, which should stimulate research in this important field.

Recent Developments in Water Filtration*

By ALLEN HAZEN,

Consulting Engineer, New York City

A Dutch author recently classified all waters in public water supplies in two classes, namely, aggressive and quiet. He defined aggressive waters as those having a tendency to attack and corrode the iron pipes through which they flow and other metal fixtures with which they come in contact. Quiet waters do not have this tendency to attack metals.

Aggressive water is very troublesome in a distribution system. The treatment of water so as to purify it adequately without making it aggressive is one of the most difficult problems at present. Water leaving the filter may be of good color, show a good bacterial test, be free from turbidity and other injurious elements, and it may appear to be in all respects suitable for public water supply, but if it is aggressive it will not be satisfactory to the users. An aggressive water attacks and tuberculates the pipes, reduces their carrying capacity, and will ultimately destroy them. In doing this, however, some of the iron of the pipes is taken up, and it is this iron which makes the water objectionable. The iron taken up causes a supplementary coagulation in the water, and the floc formed in this way settles out where the velocity of flow is low. This deposit is a dirty mud which remains on the bottom of the pipes until the flow is increased sufficiently to move it. It then moves forward with the flow and makes the water dirty and disagreeable, giving just cause for complaint.

There is another condition, similar to this, which is frequently associated with it. Water which has received chemical treatment before filtration, frequently passes the filter before the chemical reactions are altogether complete. Such water leaving the filter contains a small quantity of coagulant which separates in the pipes and produces the same conditions as those produced by the iron taken up from the pipes. Probably this condition of incomplete chemical reaction at the time of filtration is found mainly with aggressive waters. At any rate, the two conditions produce similar results and frequently they are found together, in which case, the resulting conditions are much worse than they would be otherwise.

The question of why some waters are aggressive and others quiet is presented. Twenty years ago, chemists would have stated that it was, first, a matter of alkalinity, and carbonic acid would have been mentioned as a second important contributing factor. Alkalinity and carbonic acid really have something to do with aggressive qualities, but all the conditions cannot be accounted for by them. Other explanations must be found. Recently, new methods of testing have been originated. The theory of "ions" has been developed, and it is thought by some who have been studying the matter that a connection between the "ions" and the aggressive qualities of waters can be traced. Tests based on these new ideas have been devisd, and have been applied for the first time quite recently, and at present there seems to be some hope of a method of ascertaining more definitely when water will be quiet and when it will be aggressive. Knowledge comes first, and when engineers understand better why waters are aggressive, it will be easier to find methods of treating them so as to keep them quiet.

At present, a great deal is known in a practical way as to which waters are aggressive and give trouble because of their aggressiveness. The waters of the Great Lakes are almost always quiet and can be filtered and purified in a manner to keep them so. In the Mississippi Valley, from the Alleghanies to the Rockies, the surface waters used for public water supply are generally hard, and can be handled, by carefully managed treatments, so that the resulting products will be reasonably quiet. Thus, through all that broad expanse of country the problem of aggressive waters is much less important and difficult.

Soft waters are frequent nearer the coasts, both East and West, and they often carry organic matters of vegetable origin. These waters are much more apt to be aggressive, and it is with them that the greatest practical difficulties have been met. Experience shows that it is difficult to treat some of these waters by methods otherwise effective, which will clear them up and make them satisfactory for public water supplies, and which will leave them quiet. Many of these waters require chemical treatment, and no other means of adequately purifying them has been found, but in some way this chemical treatment stirs up the sleeping ingredients of the water and makes them aggressive.

Decolorizing yellow swamp waters by means of chemicals seems particularly difficult of accomplishment without bringing out the aggressive qualities. The question of color is mainly one of esthetics, and it may fairly be asked whether the increase in aggressive qualities in decolorizing water does not largely or entirely offset the advantage gained, and whether it would not be wiser in some cases to get along with less decolorization.

The chemical treatment of water introduced many years ago had numerous advantages and came to be widely used. Many waters, however, can be treated with entire success without chemical treatment. This depends on the character of the water, and on what is to be removed from it. Chemical treatments may have been used in some cases where it would have been better to have avoided them. Decision to use them may have rested on consideration of all the other factors in the case. When the development of aggressive qualities is also taken into account, perhaps, in some cases, the decision would have been better made the other way.

It may be mentioned that one industrial establishment is now constructing a plant for purification of water without the use of chemicals. Formerly, chemically treated water was used, and experience with it has indicated the difficulty of furnishing water sufficiently quiet so that it would not damage the delicate products of this particular establishment.

The question of arranging all the treatments of public water supplies so as to keep them always quiet is one of the most interesting and important aspects of water purification at the present time.

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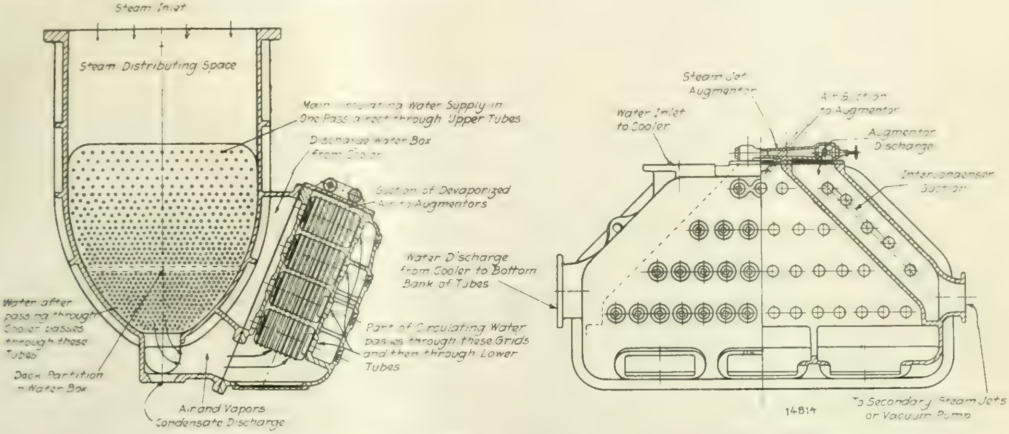
*Paper presented [illegible] before the American Society of Civil Engineers [illegible] Water Purification.

A New Development in Surface Condensers

Surface condensers are usually installed where the water available is unsuitable or unsafe for boiler feed and, while great benefits are secured for the boiler, the tube troubles are transferred to the condenser. These troubles are of two kinds: corrosion requiring continuous attention to leaky tubes which pollute the condensate and finally necessitate the expense of tube renewals, and secondly, fouling of tubes by scale or slime which causes reduction in the average operating vacuum. Particular advantages in reducing and eliminating these tube evils are claimed for the new Ingersoll-Rand line of condensers. The improvements in design may be briefly summed up as elimination of waste tubes, maintenance of uniformly high condensate temperature, counter-current air cooling, and last, but of great importance, the retardation of fouling and corrosion.


Steam Inlet
Steam Distributing Space
Main Circulating Water Supply in One Pass direct through Upper Tubes
Discharge Water Box from Cooler
Suction of Devaporized Air to Augmentors
Water Discharge from Cooler to Bottom Bank of Tubes
Water after passing through Cooler passes through these Tubes
Back Partition in Water Box
Part of Circulating Water passes through these Grids and then through Lower Tubes
Air and Vapors
Condensate Discharge
Steam Jet Augmentor
Water Inlet to Cooler
Air Suction to Augmentor
Augmentor Discharge
Intercondenser Suction
14814
To Secondary Steam Jets or Vacuum Pump

Cross-Section Through Main Condenser and Cooler of Ingersoll-Rand Surface Condenser.

The fundamental characteristic of the design is the elimination of waste tubes. This is secured by arranging the tubes in "stages," by correct shell shape, and by the use of a separate devaporizer—cooler. The tubes, spaced on wide centers in the top of the shell, are brought closer together in each lower bank or stage. The shell itself is gradually narrowed from its width at the top to that of a nozzle running the length of the shell under the last row of tubes, giving it the characteristic heart-shaped section. Sufficiently high steam velocities to sweep condensate and air films from the tubes are maintained throughout the condenser, by this construction which compensates for the decreased volume of the steam as it is condensed in its passage down over the tubes. The residual air and steam from the last row of tubes is drawn up into the cooler which is mounted on the side of the shell proper and fitted with cast iron cooling grids whose surfaces are particularly adapted to devaporize and cool the air before it passes to the vacuum pump. The withdrawal of the non-condensibles at the bottom of the shell and the use of a multi stage tube arrangement and correct shell shape insures an active flow of steam over every tube and precludes the possibility of pocketing and stagnation.

The condensers are furnished with high vacuum reciprocating or steam jet vacuum pumps. When the latter are used the primary jets are mounted on the air cooler and discharge into an intercondenser forming part of the cooler proper. The complete compression is accomplished in two stages, secondary ejectors being used to remove the air from the intercondenser under reduced vacuum and discharge it to atmosphere. To operate efficiently the steam jet used in an ejector must expose a large surface to the incoming air, since compression is only secured through entrainment. In the I-R ejector this requirement is fulfilled by projecting the steam in the form of a hollow cylinder and entrainment is accomplished by both the inner and the outer surface. In many cases a small reciprocating vacuum pump is used in place of secondary jets. It may be selected of a size to serve several condensers, each being fitted with both primary and secondary jets, the secondaries serving as standbys. A better plant heat balance is often secured by driving this pump with an electric motor.

Hydrogen-Ion Concentration as a Means for Preventing Corrosion

The laboratory at the Montebello Filters of the Water Department of Baltimore, Md., was one of the first to use hydrogen ion in plant control, and it is now one of the most important tests. The water at Baltimore is comparatively soft, the alkalinity being about 40 and the total hardness about 50. It is corrosive before treatment, and after the application of alum, unless neutralized by an alkali, it is so corrosive that when it reaches the consumer it may look about as turbid as it did before filtration, due to corrosion of the pipes. It is necessary, therefore, to reduce its corrosive qualities, which is done by adding lime near the outlet of the mixing basin.

In a discussion in the recent symposium of the American Society of Civil Engineers on Water Supply and Water Purification, Mr. John R. Baylis stated that it is possible to prevent corrosion almost entirely by adjusting chemical treatment to the proper hydrogren-ion concentration. With soft waters this may mean a PH value of nearly 9.0 and with hard waters the value may be as low as 7.0, or even less, without producing corrosion. For most waters, in adjusting the hydrogen-ion concentration when alum is used, the alkali should be added after filtration. Preparations are now being made at Baltimore to add the lime after filtration. The water before treatment has a PH value of about 7.0, which is reduced to about 6.5, or less, by the addition of alum, and it is later adjusted to about 8.4 or 8.6 by the addition of lime. There seems to be nearly complete precipitation of the alum if the PH value is not below 6.5, but beyond that it may not be complete. On account of the low alkalinity in some waters, it may be necessary to add some of the alkali before the alum, but only enough should be added to produce a PH value of about 6.5 after application of the alum, and then adjust it to the proper hydrogen-ion concentration after filtration. In Baltimore, it is possible to re-dissolve about one-half of the aluminum hydrate by applying lime in doses slightly higher than are necessary to the coagulated water. These re-dissolved compounds may have no effect on the water, but chemicals are wasted by this practice.

Mr. Baylis added that the hydrogen-ion concentration is one of the easiest determinations to make, and possibly is the only test that will enable the filter operator to be sure of the corrosive qualities of the water treated. As soon as the proper concentration is determined for a certain water, the necessary adjustments can be made, and complaints about corrosion or red water will cease. He believes that today the hydrogen-ion determination is one of the most important tests.

The Operations of Reservoirs for Water Supply*

By SAMUEL A. GREELEY

[illegible]

[illegible]

[illegible]

[illegible] regulation of storage, the handling of silt, [illegible] the control [illegible]

[illegible] a number of other situations. [illegible]

Summary of Data on the Use of Impounding Reservoirs. [illegible] water supplies. In [illegible] bathing is permitted. There is indicated a more general [illegible] forbidden entirely in only 7 [illegible]ns out of the 14 records available. Fishing from the shores is almost universally permitted, and quite generally [illegible] although this latter practice is commonly regulated through permits or licenses. Picnicing and camp-[illegible] permitted in about one-half the cases. [illegible] and among the more comprehensive of these methods are daily [illegible] by five mounted patrolmen over a drainage area [illegible] miles for the Oakland, Calif., water supply.

Table II indicates the data for unfiltered water supplies. In only one case is bathing reported as permissible, that is, [illegible]is, Ill., in which city the water is not used for drinking. Boating also is forbidden, whereas fishing from the [illegible] 11. [illegible] from boats is also generally forbidden, and this is also true of picnicing, camping and the development of resorts.

In the case of the impounded or lake supplies for Boston, [illegible] New York City [illegible] careful control is exercised. [illegible] by permit, and some [illegible] New York reservoirs.

[illegible] freer use of reservoir [illegible] supplies.

Comments on Bathing.—The matter of bathing appears to [illegible] It should be considered [illegible] quality of the water in the [illegible] the bathers themselves. [illegible] recently called for the serious attention of the Health Departments in Chicago, Ill., [illegible], Wis., and elsewhere [illegible] that better bathing facilities can be provided in specially designed pools [illegible] of the [illegible] of the quite general distribution of typhoid carriers, the regulation of bathing assumes increasing importance. For a short time in 1921, several public bathing beaches in Chicago were closed.

Maintenance of Reservoirs.—No large impounding reservoir for water supply can be left to itself, and some more or less continuous maintenance is required. In the first place, developments on the [illegible] area above the reservoir should be canvassed frequently so that gross pollution may be avoided. In the [illegible] the development of undesirable microscopic growths must be watched and controlled. Methods of control include a reasonable removal of the causes of such growths, the destruction of the growths by the application of minute quantities of copper sulphate, and the improvement of the water by aeration before filtration.

The third consideration involves the maintenance of satisfactory [illegible] accomplished by draining, clearing, and burning over marginal areas during low water. It is believed to be particularly important that constant patroling should be undertaken, probably by boat and automobile, so that the establishment of gross nuisances may be prevented at all times, as well as minor infringements of the reservoir use.

Recent English Data.—The writer's attention has recently been called to a moderate use of impounding reservoirs for fishing in England. [illegible] entitled "Trout in Lakes and Reservoirs," by Ernest Phillips, offers some interesting data. It appears that within the last few years about 40 or more English cities have stocked their city water supply reservoirs with fish and opened them to the public. In some of these cities, fishing tickets are issued, which cost at Manchester 25 ct. per day and at Huddersfield 50 ct. per fishing day. The speaker is not informed as to the extent of water filtration at these supplies, nor as to which.

TABLE I.—USE OF IMPOUNDING RESERVOIRS AND FILTERED WATER SUPPLIES

	Data.		Use of Reservoir						
[illegible]	[illegible]	Area [illegible]	Bathing.	[illegible]	Fising from [illegible]	Fishing from [illegible]	Picnicing and [illegible]	Resorts.	Method of [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	No	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	Yes	Yes	Cottages	[illegible] patroling.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Yes	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	No	No	No	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Cottages	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Little	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] patrol.
[illegible]	[illegible]	[illegible]	[illegible]	Yes	[illegible]	Yes	[illegible]	[illegible]	[illegible]

*[illegible]

TABLE II.—USE OF IMPOUNDING RESERVOIRS FOR UNFILTERED WATER SUPPLIES

	[illegible]		Use of Reservoir						
City.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Method of [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	No	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	No	[illegible]	[illegible] men.
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	No	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] water and road

*[illegible]

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*[illegible]

if any, are chlorinated. It is the general understanding in the United States that few of them are filtered.

Rules and Regulations.—A number of rules and regulations governing the use of reservoirs have been published and others have been suggested. Among the most complete are those of the Massachusetts State Board of Health, the Department of Water Supply, Gas and Electricity of New York City, a suggested law by W. H. Dittoe, Chief Engineer of the Ohio State Board of Health, and ordinance recently passed at Dallas, Tex., and elsewhere. The aim of these rules and regulations is to prevent entirely the use of the reservoir for fishing, bathing, and the like, or to permit some boating and fishing under careful regulation by special permits and licenses. Bathing appears to be quite generally banned.

Summary and Conclusions.—The brief time available for the presentation of this subject of the operation of reservoirs for water supplies, and the multitude of differing local conditions, do not permit general definite conclusions. Practice and experience indicate that bathing, except under most favorable conditions, should not be permitted, and that consideration should be given to the protection of bathers as well as to the protection of the water supply. With unfiltered supplies, the tendency is frequently against boating, fishing, and the like. In the case of filtered supplies, the use of reservoirs for such purposes appears to be increasing under the most thorough and careful sanitary patrol.

The Chlorination of New England Water Supplies*

By WILLIAM J. ORCHARD,

Of Wallace & Tiernan Co., Inc., New York

One thousand nine hundred and ninety-six communities in the United States chlorinate water or sewage or both with liquid chlorine. Only 128 or 6 per cent of these are in New England. Twelve are treating sewage, leaving but 116 New England communities chlorinating drinking water. Nearly half, 43 per cent, of these are in Connecticut where 51 communities use liquid chlorine to safeguard their water supplies, 24 are in Maine, 16 are in New Hampshire, 11 in Rhode Island, Massachusetts has nine while Vermont has three communities using liquid chlorine for their water supplies.

Scoring the states in this country in accordance with the number of communities using liquid chlorine and starting with New York in first place with 254, ending with Nevada in 48th place with but one lone chlorinating community we find Connecticut sands 11th, Maine 25th, New Hampshire 30th, Rhode Island 36th, Massachusetts 41st, and Vermont 47th.

A manufacturer of chlorinating equipment naturally asks why this relatively small number of communities using liquid chlorine in certain sections of New England? Now, in trying to answer that question, the speaker appreciates that he is skating on thin ice—dangerously near a deep hole labeled "The Johnsonian Controversy," and caution dictates that he skate the other way.

But it is a fact that there is more resistance to the chlorination of drinking water in New England than in any other section of the country. Some of this is due to a firm, honest conviction in the purity and safety of unsterilized water supplies—some of this is due to complete deep rooted faith in the absolute efficacy of storage and water shed patrol—but, in the writer's opinion, the principle cause for this resistance to chlorination in New England is the marked aversion found in some quarters to the application of chemicals in any form to drinking water. It matters not if, as in the case of sterilization, a barrel full of chlorine will suffice for a Woolworth building filled with water. The objection is to the application of chemicals in any form—no matter what the chemicals may be. This attitude was clearly expressed by one of New England's most prominent engineers who said to the speaker, "Up here we don't want medicated waters."

We de not agree with the opponents of chemical treatment but we have absolutely no doubt of their sincerity. We can only hope that they will believe that the rest of us are equally sincere as we try to persuade them to change their minds.

Boston for instance—or rather the Metropolitan district—is the only large community west of the Rockies that does not chlorinate its water supply as an added precaution.

But Boston points to its low typhoid records with justifiable pride, and takes the stand that perhaps other cities have to chlorinate their water supplies to obtain low typhoid rates but Boston can get a low typhoid rate without chlorination so "Why put chemicals in the water?"

Of course then comes the question of the potential danger of an untreated supply, especially where reservoirs are easy of access, but here again we approach the controversial. But, as though to compensate for some of its seeming neglect of the manufacturers of chlorine and chlorine control apparatus, New England has made many contributions to the development of the process of chlorination.

As time brings to light more facts concerning its nativity, it seems more and more likely that the experimental work of Sedgwick and Phelps at the Massachusetts Institute of Technology in Boston a score of years ago was the corner stone of our present practice in the chlorination of water supplies.

It was at Torrington, Conn., that Tiernan—then struggling with Wallace in the development of a practical ozone generator for the sterilization of water—worked with Phelps in checking a water-borne epidemic, made use of bleaching powder to sterilize the water supply and caused them to transfer their energies from ozonation to chlorination. It was at Stamford, Conn., that the first automatic chlorine control apparatus was developed, thanks to the patience and cooperation of the late manager of the Stamford Water Co.—Mr. E. L. Hatch, one of the earliest supporters of chlorination.

The first recorded reduction in color obtained by treating water with chlorine was secured at Branford, Conn., by Minor of the New Haven Water Co., where, under his patronage and with his keen interest, an entirely new type of equipment, that holds great promise, has been under test for nearly a year. It was at Exeter, N. H., that Weston first introduced liquid chlorine to water before the coagulant in order to reduce alum requirements—a procedure that has now been adopted with success by many operators. And at the abattoir at Brighton, Mass., liquid chlorine was first used to sterilize wash water used about the packing plant—a procedure that is now universal in the packing industry. At Waterbury, Conn., the Y. M. C. A. was one of the very first to use liquid chlorine to sterilize swimming pool water.

So you see New England has a considerable responsibility for the position in which the process of chlorination now finds itself and has contributed almost as much to this as it has to other developments in the field of sanitation.

There is much that New England still can do. We seem to be at a turn in the road where new standards of water are to be developed or else new interpretations placed on existing standards. With the increased attention being given to the chemistry of colloids and to the electrolytic dissociation theory as exemplified by the interest in hydrogen ion concentration, chlorination presents a wide field for study.

In New England, more than in all the rest of the country, are located the men who, since the late eighties, have guided the development of water treatment to its present stage. Their help is needed in the developments that are to come. That help will speed the day of arriving at a proper appreciation of the merits of various modes of water supply protection.

Drainage Survey by Aeroplane.—Special reconnaissance has been undertaken for the Reclamation Service of the Department of the Interior of Canada in the vicinity of Le Pas and Cumberland House, lying on the boundary between Northern Manitoba and Saskatchewan. The survey covered the Carrot River triangle for a drainage scheme involving the reclaiming for productive purposes of from 800,000 to 900,000 acres. It had been found that a large part of the area was inaccessible owing to floods, reeds and willows which made canoeing impossible. The Air Board was accordingly requested to arrange a flight over the region, so that an engineer might secure the desired information from the air. Reports from the Victoria Beach (Manitoba) air station, which was the main base, indicate, according to The Canadian Engineer, that the operation was a complete success. Most valuable data was secured in an infinitely shorter period of time than would have been possible by any method of ground transportation, and by no other method could the same general perspective have been arrived at.

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*From a paper presented at the last annual convention of the New England Waterworks Association.

Some Features of Present Water Supply Practice.*

Water Quality Standards. Standards of quality are steadily rising and bid fair to continue to rise. Communities no longer consider merely a safe water sufficient, but demand a sparkling water of good appearance. This demand has good scientific foundation for the best appearing waters are frequently the safest.

In certain sections, the southeast for instance, waters having colors of 40 to 50 are still used without complaint. These supplies would not be tolerated in northern cities supplied with lake or filtered river water or even in New England where opinion is fast getting in a position to demand water of an average color of 10 parts per million or less with a maximum of 15. Particular objection is made to colored, surface waters containing objectionable organisms and turbidity, especially due to heavy microscopic growths. [illegible] rust is also objectionable.

While the bacteriological standard of the U. S. Public Health Service met with considerable criticism because of its alleged severity and because it excluded certain water supplying communities in which good [illegible] health conditions prevailed, it can not be denied that those who are aiming to supply waters of high quality are trying to equal or better this standard which, as is well known, commands that all waters used in inter-state commerce shall contain no gas-forming organisms, presumably B. coli, in at least three out of five portions of 10 c.c. from the sample tested. One reason for this appreciation is the improvement in public health diagnosis, this, in turn, to better vital statistics, better organization of the health authorities and refinements in clinical methods.

Quite recently the significance of certain spore-forming bacteria (B. Welchii, B. Aerogenes and B. Enteriditis), when found in water, has been the subject of much discussion especially in connection with the outbreaks of intestinal disease, other than typhoid fever, at Shreveport, La., and Montclair, N. J. These spore-forming organisms are more resistant to the action of chlorine than B. coli and other non-spore forming organisms and are apt to exist in surface waters which have been chlorinated but not otherwise purified or imperfectly purified by rapid filtration. Both the nature of these organisms and their relation to disease are as yet known imperfectly and Sir Alexander Houston has recently expressed his opinion that the B. coli should still be regarded as the criterion for classifying waters with regard to their connection with gastro-intestinal disease.

Water Softening. Hard waters are objectionable in many ways. For domestic and laundry use they require large quantities of soap. They are unsatisfactory for washing because they have a deleterious effect on the finer fabrics. They are unsatisfactory for bathing because they have an irritating effect on the skin. They increase plumbing bills because of the deposition of scale in waterbacks and piping. For boiler use they cause trouble by forming scale in the boilers, which shortens the life of the boilers and fire boxes and increases the bills for fuel and repairs. In certain special industrial processes hard waters are considerably less satisfactory than soft waters, and they can not be used in certain processes, such as bleaching and dyeing establishments.

It is likely, therefore, that the increasing competition for industrial growth and the rising standards for domestic water supplies will lead to a substantial growth in water softening. The need for water softening does not depend on sanitary grounds so much as on economic grounds. The hardness of the water has little or no effect upon the public health, but for both industrial and household uses hard water is unsatisfactory. In particular, the quality of municipal water supply for industrial purposes assumes importance where towns are competing for the location of industrial plants. Many towns depend upon railroad shops and round houses or large manufacturing plants for a considerable proportion of their population. The progressive city with an ample supply of soft water will grow while others will stand still. There is a more direct economic appeal, however. Under certain conditions, depending upon the hardness of the water, the size of the town and other local considerations, the residents of a town will save money by softening its water. The relation between the cost of water softening and the saving resulting therefrom to the ordinary householder is very direct, and in many cases the saving in soap alone is sufficient to pay for the cost of softening, to say nothing of the saving in damage to the finer fabrics, the reduced cost of plumbing, etc.

There is an increased demand for softened water, particularly in residential districts and in textile dry houses and bleacheries now supplied with hard water. In addition to the limesoda process in use for 70 years, artificial zeolites, of which "Permutit" and "Delealco" are two examples, have had widespread use in the industries, in hotels and large residences and are beginning to enter the municipal field. By their use, water may be completely softened, the calcium and magnesium in the water exchanging with the sodium in the zeolite. After the zeolite becomes exhausted, it is regenerated by contact with brine, followed by washing with water.

Water Supply and Disease. Among the worthy accomplishments of the past decade has been the reduction in the typhoid fever death rate in American cities, another was the remarkably low typhoid death rate among the American Expeditionary Forces, a marvelous contrast to the records of the Spanish and Boer Wars. For example, the typhoid death rate of Massachusetts for 1920 was 2.5 per 100,000 and only five of the cities of that state had rates exceeding [illegible] per 100,000, a glaring contrast with conditions of 15 years ago when leading sanitarians were talking of "residual" death rates much higher than these actual accomplishments.

Nothwithstanding these improvements in the public health, due in largest measure to improvements in water supplies by storage, inspections, filteration and disinfection, the goal is not yet reached. Mild outbreaks of gastro-intestinal disease like a mild type of dysentery, rarely causing death, appear suddenly in many municipalities, especially in the spring, and the distribution of disease is such that the public water supply has seemed in each case to be the cause. The necessity for vigilance and study still exists and the well-known lines of defense against water borne disease must be well supported, for without watchfulness the best designed works may fail. Material assistance may be given to the water department by the community by destroying infectious material at its source, and by better use of the methods of hygiene and preventive medicine.

Water Purification. Both the advantages and limitations of storage as a method of purification have been the subject of recent discussions, the consensus of opinion being that it is a valuable and perhaps the most reliable single method, but not free from the danger of wilful or accidental contamination.

There have been few changes in the basic design of water purification plants within the past 10 or 15 years, but many improvements have been made in the details of water purification plants, particularly with respect to the pipe galleries in gravity mechanical plants, with respect to the handling and application of chemicals, and other practical matters. The use of the hydraulic pump to mix chemicals with water by J. W. Ellms, in the Milwaukee experiments, seems to be a simple and effective substitute for the older methods of baffled channels, agitators, [illegible] and other mixing devices.

Where filtration and softening are combined difficulties resulting from the so-called balling up of the filter sand, due to the accretion of lime deposits on the sand grains in the filter beds, are being overcome by several methods which have been developed recently.

The knowledge of the handling and application of chemicals used in the treatment of water has been vastly benefited by the researches of physical chemists in recent years.

The difficulties of treating colored water and waters of low alkalinity to produce an effluent free from color, turbidity and colloidal aluminum hydrate and one which would not erode or corrode service pipes and plumbing, are well known. While many operators have surmounted the difficulties connected with the purification of such waters, they have done so by methods largely empirical. It was difficult to find a scientific basis for proper treatment or reasons for failure. Recently, however, water chemists have made use of the hydrogen ion concentration and the method bids fair to explain much which is now obscure.

The Hydrogen Ion Concentration.—Briefly the hydrogen ion concentration is a measure of the reaction of the water, of its acidity or alkalinity, but it is a delicate and discriminating measure and gives information which the ordinary alkalinity determination does not. By hydrogen ion concentration is meant the concentration of disassociated or active hydrogen in the water. The standard alkalinity determination measured the total amount of alkali present, but it did not measure the concentration, either before or at any stage in its neutralization. The determination of the hydrogen ion concentration gives by difference the concentration of the alkalinity at any time, and this is a factor that is often of very great importance to know and which may throw a great deal of light on proper application of chemicals in water purification plants. We will not attempt a technical discussion of hydrogen ion concentration at this point but simply wish to call attention to the benefits which may result from this method of measuring the reaction of the acidity or alkalinity of water.

Laboratory Work in Water Purification.—Our more progressive officials are beginning to realize that water purification is not only a problem of hydraulics and mechanics, but a problem of chemistry and biology as well, and are giving more encouragement to laboratory work. It is unfortunate that very little attention has been given to the laboratories at water purification plants in the past. The larger plants have had well equipped laboratories from the beginning, and expert chemists and bacteriologists were employed to carry on the routine analysis necessary for the proper operation of such plants, but very few of the smaller plants maintained properly equipped laboratories and fewer still had anyone connected with the plants who had a fair knowledge of chemistry or bacteriology. This practice is fraught with much danger for the reason that the existence of a filter plant gives a feeling of security to a community, whereas a filter plant without proper supervision may be but a blind to camouflage a really critical situation.

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*[illegible]

State Supervision of Water Purification. Fortunately, however, at the present time boards of health in many cities, and particularly in many of the states, are taking a hand in the supervision of water purification. It has become necessary for the water departments to report to the health boards the result of their chemical and bacteriological analyses. This has resulted in the establishment of laboratories in nearly all except very small plants. Closer attention is given to the results obtained for the health departments are also testing water. In some states the supervision of filter plants has gone so far as to require all operators to be licensed. The state of New Jersey, so far as we know, has been the pioneer in this respect. On Feb. 9, 1918, an act was passed relative to the examination and licensing of operators. This act authorized the State Department of Health to examine prospective operators and to issue a license providing the examination of the applicant proved him to be capable of performing those duties which would be required of him. It is further provided that every purification plant must have a licensed operator. This is a step in advance and should result in better filter plant operation.

It is to be remembered, however, that the licensing of operators and the making of daily routine analyses are not all that is required. The water works superintendent should give greater attention to the analysis of the water supply under his charge. Analyses are useless unless used, and this observation is true with regard to all operating data in a water works plant. The mere collection of the data is not sufficient. It must be used and applied.

Electrolysis.—Ever since the advent of the street railway, water-works plants throughout the country have complained of electrolysis of mains and service pipes. The term "electrolysis" embraces the entire process of accelerated corrosion of underground metallic structures due to stray currents.

The practical electrolysis problem is due to stray currents from electric street railways. Instances of stray currents from other sources sometimes occur, but such cases are rare and are not specifically considered.

Electiric currents straying to earth from electric tracks frequently find their way to water and gas pipes, telephone and power cables, and other underground structures. When this current leaves these structures through earth, corrosion results. Thus not only are the structures of many different companies subject to injury, but by reason of the different public services dependent on such structures, the public as a whole has a direct interest in this type of electrical interference.

As the investment in pipes and service connections in the towns and cities of this country is enormous, the added depreciation resulting from electrolytic corrosion represents a large economic loss to the municipalities of the country. Suits were brought in several instances to compel the street railway companies to modify or change their system of operation or to secure damages for electric corrosion. No definite beneficial results were obtained from these studies for the reason that the data were not sufficient on which to base a determination of the minimum residual amount of stray current which was permissible and which would not cause injury to underground metallic structures nor whether it was feasible for the street railways to keep the stray current down to this minmum residual

Coagulation and Sedimentation in Water Purification.*

By J. W. ELLMS

The Frazier-Ellms-Sheal Co., Consulting Engineers, Cleveland, O.

Coagulation and sedimentation with chemicals, followed by rapid filtration through sand filters, have become the generally adopted methods of purifying the public water supplies in the United States. Even where the softening of a water supply comprises the principal portion of the process, coagulation, sedimentation and filtration are important factors in the final cleansing of the water. The method of applying the chemicals and the effects they produce are, therefore, of the greatest significance.

If the phenomena accompanying the processes of coagulation and sedimentation are carefully studied, it soon becomes evident that we are dealing with chemical reactions on a large scale, and that the physical changes brought about by these reactions are governed by principles and laws which have been investigated by scientists within comparatively recent years, and classified by them under the names of physical and colloidal chemistry. The phenomena are complex and by no means entirely understood in all of their ramifications.

The object of the present paper is to outline and classify the various factors entering into the processes of water purification without going too deeply into details. The practical value of understanding the main features of these processes in relation to the design of the structures in which they occur is obvious, and at least may justify the effort to set forth in an orderly manner the changes that take place.

Removal of Suspended Impurities.—Excluding for the time being those phases of the problem which relate to water softening let us consider those which have to do with purification and clarification, that is, with the removal of suspended impurities. In natural waters used for public supplies there are usually found both inorganic and organic matter which are not in solution, but which are in a very finely divided state. Some of this material does not readily settle out even when the water is quiescent. Some of the organic matter appears to be in actual solution, although it has been discovered that this is not always the case. Such material will not precipitate unless the size of the particles of which it is composed is enlarged, or is trapped by other material which is collecting into larger masses and thus becomes capable of being deposited by sedimentation.

The impurities referred to in the above paragraph consist chiefly of inorganic compounds or mixtures commonly known as clay and silt, and of organic matter, both dead and living. In the dead organic matter may be found nitrogenous and carbonaceous compounds, and in the living matter, bacteria and microscopic plant and animal forms. Much of the inorganic material is in that finely divided condition known as the colloidal state of matter. The dead organic matter is usually in this condition, while the cells of the living organic matter may be always considered as in this form.

Since a portion of the suspended impurities are, on account of their extraordinarily small size, not capable of settling out unaided, it becomes necessary to add something to the water which will cause these particles to come together. The aggregation of these particles into masses of such size that they may settle out is commonly known as coagulation. This process is usually effected through the agency of a chemical compound such as aluminum sulphate or ferrous sulphate which, in reacting with the natural alkalinity of the water or with an alkalinity created by the addition of lime or soda ash, produces a colloidal precipitate. The latter by reason of the electrical charges upon its particles and which are of opposite sign from those on most of the natural colloidal impurities, brings about coagulation of the suspended matter, and subsequently is settled out under proper conditions.

Chemical Reactions.—From the above it is evident that there first occurs one or more chemical reactions followed by certain physical changes. It is this actual division of the process into two parts to which attention should be directed, if the full significance of the phenomena involved is to be understood. The reaction between the sulphate of aluminum and the alkali in the water is the usual exchange of irons, whereby an insoluble or practically insoluble product is one of the results of the reaction. Every precipitation is preceded by a state of supersaturation with respect to the precipitated solid, and after it is complete, the liquid is saturated with it, i. e., it is in equilibrium with the liquid. The establishing of this equilibrium may require considerable time, and depends entirely upon the properties of the compound resulting from the chemical reaction, and from the physical and chemical characteristics of the water in which the reaction takes place.

It is necessary, therefore, to realize that a chemical reaction or series of reactions precedes changes which establish physical equilibrium. The velocity of most chemical reactions, at least of those commonly met with in water purification, is extremely high, in fact too high to be able to properly measure the time in which they occur. The higher the temperature the more rapid are the ionic exchanges If more than one reaction is necessary, as in the case of ferrous sulphate, and lime or lime and soda ash in water softening probably a somewhat longer time is needed, but even here the chemical reactions practically complete themselves in an immeasurably short space of time.

The foregoing statement is only true if the reacting substances are in solution The velocity of a reaction is directly proportional to the concentration of each reacting constituent, and is understood to be the ratio between the amounts of the transformed substances and the time required for transforming them. The greatest velocity-value is at the beginning of the reaction, and becomes less and less as the reaction proceeds, and leads to the theoretical result that the reaction is only complete after an infinite length of time But while this may be absolutely true, for practical purposes any residual action may be regarded as non-measurable after ten times the period which is required to complete the first half of the reaetion. Since for hogeneous mixtures of reacting solutions of the general character used in coagulating a water, the velocity of the reaction at the start is very high, it follows that the reacting quantities in the desidual action are practically negligible. However, in non-homogeneous mixtures, such as occur when feeding milk of lime, or dry

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*From paper presented at the last annual convention of the American Waterworks Association.

[illegible] of colloidal [illegible] aluminum sulphate [illegible] of iron, [illegible] these [illegible] greatly [illegible] of the [illegible] a [illegible].

[illegible] that, [illegible] adjustment of the [illegible] by the [illegible] as a colloidal [illegible] and with which [illegible] difficult [illegible].

When aluminum hydroxide is one of the [illegible]. It is [illegible] appears to [illegible] effect. [illegible] in the water [illegible] of negatively charged colloids [illegible] the positively charged particles of aluminum hydroxide [illegible] of suspended matter.

In the case of ferrous sulphate [illegible] that produces [illegible] always added with the [illegible] is rapidly converted into [illegible] hydroxide and calcium carbonate. The oxygen dissolved in the water rapidly oxidizes the ferrous [illegible] to the ferric condition and there is finally produced ferric hydroxide as the coagulating compound [illegible]. Here there are a series of reactions [illegible] by the usual phenomena of matter in the colloidal condition.

Water Softening.—In the softening of water with lime and soda ash the [illegible] exchanges between the CO_3, HCO_3, SO_4, Ca and Mg ions constitute a series of chemical reactions [illegible] with physical changes [illegible] require more or less time for their completion. Calcium carbonate comes down first in an amorphous form and in this state is perceptibly soluble in the water. The amorphous form gradually changes to the crystalline [illegible] the [illegible] forms of calcite which is much more insoluble in the water. Magnesium carbonate is very soluble in water and even the hydroxide is relatively soluble [illegible] an increased concentration of hydroxyl ions, produced by adding an excess of alkali [illegible] O, H or NaOH), decreases its solubility sufficiently to cause most of it to settle out.

In water softening considerable masses of [illegible] sludge are usually in contact with the water during the purification process. Since equilibrium must be established between the water (which is supersaturated at the beginning of the process with respect to the precipitated solids) and the precipitate, it follows that intimate contact of the [illegible] with the liquid will hasten the change from a state of supersaturation to one of saturation, which latter is the stable condition desired. This [illegible] is [illegible] by exposure of large areas of the precipitate to the liquid and by agitation. The practical significance of these conditions is apparent, since by [illegible] the surfaces of the reacting [illegible], by [illegible] surface contact of the liquid with the precipitate and agitation of the mixture, [illegible] as it is [illegible].

Colloidal Reactions.—If we now consider the [illegible] that the [illegible] are [illegible] all related to matter in the colloidal state. For example, [illegible] sums up the colloidal reactions when aluminum sulphate is applied to natural waters as a coagulant as follows:

First there is formation of a positively charged colloidal hydroxide. Second this hydroxide reacts with the negatively charged [illegible] of other colloids. Third, the excess colloidal aluminum hydroxide is [illegible] by [illegible]. Fourth, the positively charged color [illegible] by the negative [illegible] sulphate ion. Fifth, any color [illegible] by the hy[illegible].

The mutual precipitation of oppositely charged colloidal particles appears to be the [illegible] of the coagulation [illegible]. It has been noted that the effect of an electrolyte upon a [illegible] is [illegible] to diminish the [illegible] between the disperse [illegible] and the [illegible], and precipitation will [illegible] when the potential difference [illegible] near to zero, the point of electric neutrality or the isoelectric point. A definite concentration of [illegible] is [illegible] necessary for precipitation, and a smaller concentration [illegible] only partial precipitation or [illegible] at all. It is not improbable that [illegible] concentrations may also produce [illegible] or no precipitation.

The [illegible] suggested between these principles and the facts well-known to operators of purification plants is worth noting. For example, it is almost always [illegible] that there is a minimum quantity of coagulant below which the most imperfect and unsatisfactory coagulation is obtained. [illegible] several years ago found that a both highly colored and turbid water, which [illegible] a mixture of two waters which reached the filter plant before sufficient time had elapsed for natural precipitation of the colloids, required the addition of alkali before the alum would precipitate. The color was not completely removed even then. By adding an access of alum first which gave an opportunity for the aluminum and sulphate ions both to act, and then introducing the alkali so that aluminum hydroxide would be formed, a satisfactory coagulation resulted with a much smaller quantity of the coagulant.

Protective Action of Colloids.—The protective action of certain colloids in preventing coagulation is illustrated by the fact that a water containing considerable sewage requires more alum for purification than an unpolluted water having the same turbidity and color. The fact established by colloidal chemists that by adding a reagent slowly to a colloidal solution more is required to produce precipitation than if added rapidly, may afford a possible explanation for some of the poor results obtained in some purification plants. The phenomena of absorption, depending as it does principally upon the factor of "surface concentration"; that is, upon the difference of concentration at the boundary between two heterogenous phases, whether the phases be gas, liquid or solid may account for many of the obscure and puzzling phenomena of the sand filtration of coagulated waters.

Like all new developments in science, [illegible] has been seized upon to explain many phenomena which are [illegible] and which will eventually be found to require the formulation of entirely new and unexplored principles. If investigators, however, will bear in mind that from the facts concerning the colloidal state of matter principles and laws are [illegible] being developed and by use of which explanations of some of the obscure phenomena in coagulation, sedimentation and filtration of water may be found there [illegible] be a real advance in the art of water purification.

Personals.

W. A. Layton has been appointed [illegible] Kan.

Leroy Pharr has been appointed city [illegible] Ga.

C. Watt Saddler has been appointed city [illegible]

C. Arthur Poole has been appointed city [illegible] N. Y.

William B. Varney [illegible] has been appointed city manager.

Frank Shepley has been appointed [illegible] County, Indiana.

Norman E. Brown [illegible]

D. H. [illegible] has opened an office at [illegible] the [illegible]

E. Harold A[illegible] [illegible]

Harry D. White [illegible] his [illegible] local [illegible] of the [illegible] will [illegible]

The Associated Engineers [illegible] Kibbe [illegible] the president [illegible] Mr. Kibbe the secretary and treasurer [illegible] a member of the Metropolitan [illegible] of Milwaukee [illegible] member of [illegible] Engineers Society [illegible] member of A. A. E. and [illegible] the Society of American [illegible] and holds a reserve commission [illegible] formerly with the Chicago [illegible] & Milwaukee R. R. Electrical Department. Mr. Kibbe is with [illegible] a member of the Chemical Society and A. A. E.

Industrial Notes.

The Chicago Gravel Co., [illegible] Fisher Bldg., Chicago, announces the appointment of George W. [illegible] as sales manager of the company, with headquarters at the Chicago office.

The Orton & Steinbrenner Co. of Chicago, manufacturers of locomotive cranes, clam shell [illegible] buckets and coal crushers, has [illegible] arrangements with Walter [illegible] Ave., Los Angeles, Cal., to represent the company.

O. A. White, advertising manager for The Fate-Root-Heath Co., Plymouth, O., manufacturers of Plymouth gasoline locomotives, [illegible] to speak before the Fifth [illegible] Stone Convention, to be [illegible] Hotel, Chicago, Jan. 16-1[illegible].

Hercules Powder Co. has announced the following [illegible] in the prices of Hercules blasting caps and electric blasting caps: Hercules No. [illegible] blasting caps reduced $2 per 1,000. Hercules No. [illegible] blasting caps reduced $5 per 1,000; [illegible] electric blasting caps copper wires [illegible] per 100. A revision also has been made in quantity discounts.

Trade Publications.

The following trade publications of interest to engineers and contractors have been issued recently:

Centrifugal Pump.—Evinrude Motor Co., Milwaukee, Wis. Circular devoted to the Evinrude portable centrifugal pumping unit.

Crane.—[illegible] Works, Bay City, Mich. Catalog [illegible] and describing a new [illegible] crawling tractor crane of 20,000 [illegible].

Generators.—Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Circular [illegible] describing the "E V" type of [illegible], vertical water wheel driven generators.

Centrifugal Pumps.—Goulds Manufacturing Co., Seneca Falls, N. Y. Bulletin descriptive of [illegible] driven centrifugal pumps, the new addition to the Gould line of pumps. [illegible] of the various pumps [illegible] and tables of standard [illegible].

Turbine Generators.—Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. [illegible] describing Westinghouse [illegible] units. [illegible] the reaction and impulse types of turbines, both the single double flow type and the multiple [illegible] type. [illegible] are described and [illegible]. The [illegible] and [illegible] the latest types [illegible].

Railways and Excavation Monthly Issue

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Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railway Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Management and Office System

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E. & C. Index Furnished Only on Request

The index for Vol. LVI—July-December, 1921 issues of Engineering and Contracting is now being prepared. In common with many other publishers we have adopted the practice of sending the index to only such subscribers as request it. Therefore, if you want the index for the last 6 months you should notify us at once. Those who requested the index for the previous volumes have been listed and need not notify us again.

An Unwise Decision of the Illinois Public Service Commission

Everyone that has read many rate case decisions must have been struck by the frequency with which public service commissions have prescribed rates that admittedly yield less than 6 per cent at the time of the decision, on the ground that the low rates would attract more business and thus eventually lead to adequate profits. Not a few decisions have been based on the analogous argument that better management would eventually lead to greater profits, and that consequently the utility company should be penalized by low rates until such time as its management has improved. It was this argument that Mr. (now Justice) Louis Brandeis used a decade ago when he was attorney for a group of Eastern shippers that were asking the Interstate Commerce Commission to lower railway rates. To its credit, the Commission refused to follow the sophistical reasoning of Mr. Brandeis. The Commission properly held that it would be a putting of the cart before the horse to order a reduction in freight rates prior to a reduction in operating expenses.

In the recent attempt of the city of Chicago to secure reduced street car fares the attorneys representing the city used the same sophistry that Mr. Brandeis used ten years ago; and it seems to have had its effect, for the Illinois Public Utility Commission ordered a reduction of street railway fares to 5 ct. The Commission conceded that, based on present operating revenue and expenses, a 5 ct. rate is woefully inadequate, but it argued that better management will lower operating expenses and that lower fares will attract more businesss.

It is noteworthy that not a single member of this commission ever managed any sort of public utility and that the engineering witness of the city had never been a street railway engineer. Yet an inexperienced commission followed the advice of an inexperienced engineer, and ordered the most unjustified reduction in street railway rates. The Commission's decision was to take effect at about the end of November, but was blocked by a restraining order from the court. On Jan. 9, a federal court composed of Judges Carpenter, Page and Evans concurred in granting an interlocutory injunction which presumably will stand against enforcement of the Commission's order until after the hearing and decision on the application for a permanent injunction.

What we have just said of the principles of this issue is given striking sanction by Judge Carpenter's opinion, from which we quote briefly.

> "The orderly [illegible] and [illegible] method of procedure would have been for the commission to outline these various changes in management and operation, and invite the company to put their suggestions into force, giving the company an opportunity to demonstrate the benefits or even the possibilities of the order.
>
> "All of the changes suggested by the commission were matters of conjecture and opinion, and it is quite within the range of human thought that some of the changes could not be carried out to advantage, either to the company or to the people. Why, then, should the Illinois commission [illegible] discounting the possibility of performance, direct a rate which both it and the city of Chicago admit will not pay operating expenses, to prevail until their views are adopted."

But regardless of this decision or of the subsequent decisions which we doubt not will make the injunction permanent, a great harm has been done, for many of the public will have been convinced that the State Commission ruled justly. If the conviction is widely spread it will lead to municipal ownership of street railways in Chicago and thus add one more economic blunder to the list headed by San Francisco and Seattle.

If ever public regulation of utility rates is to become an unqualified success it must become a fixed policy of public utility commissions not to lower rates prior to the existence of excessive net earnings unless a utility company expresses a willingness to experiment. It cannot be denied that the managers of every utility company are anxious to secure large net earnings. Therefore any intelligent manager would gladly lower rates were there a good prospect of increasing business **enough to increase the net earnings. Indeed, prior to the days of public regulation of utility rates,** there was a steady decline in most rates due to the desire of managers to increase business and profits coincidentally. It was their foresight that brought railway rates in America down from [illegible] ct. per ton mile in 1860 to about ¾ ct. per ton mile in 1890. It was this foresight that led to the progressive lowering of the electric light and telephone rates. Street car rates were not lowered per ride but they were lowered **enormously per mile of transportation during the same** period for the growth of cities and suburbs lengthened the average pas**senger haul several fold. All this occurred prior** to public utility regulation, and because utility managers pursued the wise policy of lowering rates as fast as reduced operating expenses made it possible. Utility managers are certainly not less sagacious today than they were twenty years ago, and can be trusted to act now as they did then, provided they are assured that all benefits from decreased operating expenses will not be immediately seized by the public through the acts of its representatives. In short, a public utility commission steps beyond its real promise when it usurps the functions of the managers of utility companies. A manager's prime function is to produce profits from an adequate service, and he can be surely trusted to lower expenses and to attract by low rates as large a volume **of trade as possible—always provided that the stockholders of his company become to some extent the gainers by his** efforts.

In their zeal to protect the public, many utility commissions overlook this last proviso, and they often seek to secure for the public not only part of the reduced expense of operation, **but all of it. This is bad enough economics, but how much** worse is it to try to secure all of an anticipated saving in advance of its realization! Yet this is precisely what the Illinois Public Service Commission has attempted to do in the Chicago street railway case. Does this commission be**lieve in regulation rather than in municipal ownership? If** so, it is **acting contrary to its belief, for a few more such de**cisions will go a long way toward greasing the skids upon which the city of Chicago will slide into the slough of owner**ship of street railways and other utilities**

What Is a Reasonable Rate of Return for a Regulated Utility?

In the preceding editorial we have referred to a 6 per cent return not because we **consider it fair or adequate, but be**cause it represents approximately the lower limit within which regulation may be conducted—the limit below which courts commonly consider return rates to be confiscatory.

It is interesting to consider this in the light of current bond interest rates. The first mortgage bond represents the safest type of corporate security. Back of every good first mortgage there stands property with a value substantially greater than the face of the mortgage, which property excess is paid for from the sale of junior securities whose return rates to their purchasers must be greater than the first mortgage rate approximately as the risk of the investment is greater.

First bonds are sold to pay for property, and they give no right to participation in the management. Unless the interest is defaulted the only attention they require of the owner is the periodic clipping and cashing of the coupons and at maturity the collection of the principal. An investment in stock is of a different type from an investment in business [illegible] the other requires much, and naturally he who [illegible] a business care along with his investment is going to demand a greater return than he who [illegible].

Before us is the January investment list **of one of the** strongest, most conservative and most reliable **security deal**ers in the Middle West—the bond department **of a great bank.** In its policy of conservation, this bank shuns **stocks entirely, and handles only such bonds as it can recommend as highly** safe investments. The first mortgage bonds on its list are as follows:

Type of Property	Due	Net yield at present prices Per cent
Public utility	1930	6.75
Public utility	1940	6.50
Public utility	1946	5.80
Public utility	1943	5.50
Public utility	1944	6.45
Public utility	1956	5.85
Railroad	2003	5.40
Industrial	[illegible]	6.15
Industrial	[illegible]	5.90

The simple average of the above yields is 6.03 **per cent; the widest spread among them is 1.35 per cent. The bank** is bringing out no new issues at this time, and every **bond here listed represents an established, "well seasoned" secur**ity. New issues bring higher rates. The factors affecting **bond prices are manifold, and we attempt no complete analysis** here, but we note that in general the highest grade of such **securities, with an active market, maturing in not less than** 10 years, and practically non-callable within that time, are selling to yield from 5.60 per cent to 6 per cent. Securities **of equally high grade except for a less active market yield** from 6 per cent to 6.75 per cent. Most of the new issues sell to yield above 7 per cent.

It is a false argument to say that because bond prices are rising and yields falling, these figures are not criteria. Interest rates once were, and probably again will be, lower than **they are now, but for several years they have been higher and during these years they represented an actual condition**—not a thory. That regulation which holds down utility rates because of an anticipated reduction in interest rates at an unknown future time is most obviously unjust. It establishes the most favorable conditions as a standard, and then **penalizes the regulated corporations whenever those condi**tions (which are for the most part beyond the utilities' con**trol) drop below the standard.**

To summarize: The best of the old and seasoned first mortgages yield 6 per cent; the new issues yield 7 per cent and upward; a large amount of property not paid for out of **first mortgages should yield higher rates; something must be provided for managerial profit if the utilities are to be treated fairly and given an opportunity to compete with other business in the financial markets; in discussing bond rates we have given data only for the best; the average bond** obviously will be inferior and so must be sold to give a higher yield—a fact which appears to be very generally ignored by commissions.

All of this does not determine what is a fair return rate for public utilities, but it pretty clearly demonstrates the inadequacy of 6 per cent.

Look Who's Here

Something novel has been taking place in the railway field since the first of the year: The railways have begun talking of new construction, of betterments, and of other improvements—and what is more to the point some lines actually have been awarding contracts.

It has been a long time since items like the following appeared in the newspapers:

Executives of the Canadian Pacific Railroad company are considering appropriations of more than $25,000,000 for road extension and general improvements in 1922. It is expected most of the construction work will be done on western lines.

The Chicago, Milwaukee & Gary R. R. has received authorization to build a new line [illegible] miles long from Aurora to Joliet, Ill., at a cost of $2,700,000.

A 12-mile line is to be constructed from the Cumberland River branch of the Louisville & Nashville R. R.

The Mingo Valley R. R. Co. plans the construction of a line across Mingo River southward to connect with the Montour R. R.

The Apache Ry. Co. has asked permission to issue notes and stock for constructing a new line from Holbrook, Ariz., to Cooley, a distance of 73 miles.

It is has been a still longer time since we had the pleasure of noting items like the following:

The Missouri Pacific R. R. opened bids Jan. [illegible] for grading for double tracking between Kirkwood and Washington, Mo., a $[illegible]000 job.

The Great Northern R. R. received bids Jan. [illegible] for laying a second track on its main line between [illegible] Miss. and Lamma, a distance of 22 miles.

The Illinois Central R. R. awarded a contract for a 5-mile cut-off and track laying job in Kentucky.

The Missouri, Kansas & Texas R. R. awarded a contract for grading and culverts for its new freight terminal at Denison, Tex., the work including 800,000 cu. yds. of grading and 6,000 cu. yds. of concrete.

A contract for grading and bridging for [illegible] miles of railroad in Mexico was let to Texas contractors.

Individually these items do not mean so very much, but collectively they make a respectable showing, a showing for two week railroad construction news that has not been equalled for over 7 years. Coming from so many sections of the country and from so many different sources and more important still at a time when the net earnings of the railroads are becoming more favorable, the news of the first two weeks of this year may be considered as a favorable indication of better and busier times in the railroad construction field.

Some Remarks on Contract Forms

To the Editor: Efforts looking toward the standardization of construction contract forms in general, following more or less successful efforts particularly during the past six or seven years to evolve satisfactory uniform contracts in specific lines of construction, are entitled to the earnest and helpful consideration of everyone interested in proper business procedure in connection with construction work.

The writer is pleased to accept this opportunity to emphasize a few fundamental considerations of vital importance in connection with contract forms. First, it should be borne in mind that a construction contract is simply an agreement between two parties, one of whom, the contractor, agrees to perform certain work for a stipulated sum to be paid by the other party, the owner. Inasmuch as each of the parties is held individually responsible for the carrying out of the contract it would appear of prime importance that its wording be so simple as to be comprehensible to both parties without the intervention of an interpreter. Moreover, inasmuch as no one not a party to the contract may be held responsible in any degree thereunder, requirements or intimations in the body of the contract that either party must look to an outside party for the performance of certain necessary incidentals to the carrying out of the agreement between the owner and the contractor are likely to involve misunderstanding and confusion if not grave injustice.

Simplicity, definiteness and fairness then are prime considerations underlying the ideal contract. It should also be borne in mind that both efficiency and fair-play require that the imposition of responsibility must be accompanied by the investiture of authority fully commensurate of such responsibility. In other words, insofar as a contractor is held responsible to the owner for the performance of certain work he is entitled to absolute and exclusive control thereof and the terms of the contract should protect him from interference either by act or neglect on the part of the owner, his representative or any other party not subject to the control of the contractor. This means, of course, that if the owner choose to reserve portions of the work from the general contract and to let separate direct contracts for same he must assume full responsibility for the acts or neglects of these secondary contractors with respect to the interests of the general contractor. It is the opinion of the writer that if owners were fully advised as to their legal responsibility and contractors as to their legal rights in this regard the practice of letting work under segregated contracts would be less popular than it is today.

Comment on certain specific provisions is offered as follows:

The wording of contracts generally implies a degree of authority and responsibility on the part of the architect that cannot rightfully be exercised by anyone not a party to the contract. Contracts should distinctly provide that the authority of the architect or engineer is the delegated authority of an agent and should convey the clear impression that the contractor may always appeal direct to the owner and that the owner may not hide behind the architect or engineer. It is suggested to this end that the wording of most contracts would be improved by providing that the owner through the architect shall furnish all plans, details, working drawings and other instructions necessary to the realization of the plans and specifications.

Inasmuch as the owner often elects to reserve certain portions of the work from the general contract it is desirable that the contract definitely hold the owner responsible for all necessary materials, labor, workmanship and incidentals not included therein and that same shall be furnished so as to facilitate the progress of the work in general as required by the general contractor.

Provision should also be made that the owner shall pay all royalties and incidental fees involved by the plans and specifications except such as are individually specifically otherwise provided for, it being the province of the architect or engineer in preparing the plans and specifications for the owner to avoid unnecessary obligations of this nature and to inform bidders of the necessary ones.

In compliance with recognized practice and to obviate doubt the contract should provide that in case of conflict between the plans and specifications the latter shall govern and that no branch or class of work not covered by the specifications shall be included in the work even though shown in part or in whole on the drawings.

In view of the tendency of many architects, on the authority they have assumed through the medium of the general conditions of their specifications, to meddle in matters with which they have no concern, the contract should distinctly provide that no portions of the specifications in conflict with the terms of the contract or not actually descriptive of the work to be done or the manner in which it is to be done are to be considered as part of the contract but shall be null and void.

When a contractor receives plans and specifications for certain work, especially if it is apparent that the owner has had expert advice in their preparation, he is warranted in assuming that they comply with the requirements of law. In view of the prevalence of misleading and unjust attempts to impose responsibility in this regard on the contractor through the medium of the general conditions of the specifications, it is suggested that the contract contain a provision to the effect that "anything that is expressly stated or shown in the plans and specifications shall govern and be followed notwithstanding anything to the contrary from other sources of information or authority to which reference may be made."

Provision for payments should be made generally applicable to varying conditions by requiring that the architect deliver proper certificate, or in lieu thereof a sufficient reason in writing for not issuing the same, within three days after receipt of the demand, in default of which the amount demanded shall thereupon become due and payable. Delay in making payments should be made to render owner liable to contractor for all damages and expense the latter may suffer thereby, together with interest on deferred payments at short term rates and extension of specified time for completion to the extent of such delay; and should provide further that, if the owner fails to make any payment within seven days after its maturity and presentation, the contractor may, after three days' written notice, terminate the contract and recover from the owner adequate compensation for all work done, loss sustained on plant, material or workmanship furnished or ordered for the work, reasonable profits, including anticipated profit on uncompleted portion of work, and damages.

Furthermore, inasmuch as the architect properly ceases to function with the completion of the work, the contract should make his certificate of completion his final act with respect to the contractor and his work and should not require the contractor to obtain from the architect a certificate for his final payment.

The writer believes the best interests of all concerned would be conserved rather by a contract that encourages than by one that threatens. Hence, the reciprocal principle of forfeit and bonus in connection with the penalty clause is advocated, where applicable; and in all other cases that a specific penalty for each day's delay beyond a certain date be named in the call for bids. So-called "liquidated damages" are an offense and an imposition and should not be tolerated.

The arbitration clause is an extremely important feature of a contract and the writer hopes to see the time when in all [illegible] as under the new law in New York State, arbitration provisions in contracts will be enforceable and irrevocable. For the ordinary building contract, however, the questions in dispute are in general of insufficient importance to warrant the detailed procedure that would have to be required by law. But every contract should contain an arbitration clause, specific and mandatory enough at least to encourage just and equitable settlements of disputes and to relieve the architect from any impression that he may assume to be the sole interpreter of his own plans. Such a clause should provide for primary decision by the architect subject to appeal by either owner or contractor to a board of arbitration with plenary power. In order to protect either party from the indifference or stalling of the other it should be so provided that either may force a prompt arbitration; as, for example, by providing that the board consist of three disinterested men experienced in the business of building, one to be named in the demand for arbitration by the party making the demand, one by the other party within five days thereafter and the third by these two; neglect of either party to appoint an arbitrator within five days after such demand has been delivered to operate to place the question before the arbitrator named in the demand, whose decision shall be as binding as that of a full board. It should be provided that the notice of the appointment of the third arbitrator shall designate a time and place for the first meeting of the board and either party should be empowered to require that the decision of the board be rendered within 15 days after written demand therefor has been made, the life of the board to be limited to said period unless extended by written consent of both parties. Should the life of such board terminate without a decision being rendered provision should be made for the appointment of a new board, but no person should be qualified to sit on more than one board of arbitration to consider the same question.

The basic purpose of every straight construction contract is the completion of a specified amount of work which the owner wants done and which the contractor wants to do. The sooner the work is completed as specified the better for both parties. It is to be expected that the parties will cooperate to the fullest extent in the completion of the contract. The owner cannot consistently countenance any interference with the convenience of the contractor in his efforts to comply with the contract requirements. To this end the contract should provide that the owner (not the architect or engineer) shall furnish or cause to be furnished, free of charge, as required and in any event promptly on demand of the contractor, such additional instructions by means of drawings or otherwise as may be necessary for the proper execution of the work.

Inasmuch as the personality of the architect or engineer that is to oversee the work for the owner may be of vital concern to the contractor, the latter is entitled to know in advance with whom he will have to deal; and the contract should provide that any change shall be subject to the approval of the contractor.

Such provisions as that "the architect's decisions, in matters relating to artistic effect, shall be final," are indefinite and intangible and have no proper place in a contract. Any work not susceptible of definite description in the plans and specifications is by the same token not susceptible to an accurate cost estimate. Such work should be covered in the specifications by a fixed allowance and all guess work eliminated.

Such provisions as that the employes and subcontractors shall be satisfactory to the owner, architect or engineer are in direct violation of the established right of the contractor to absolute control of the work he has obligated himself to perform according to specifications.

A provision is often inserted in contracts requiring the general contractor to submit to the architect or engineer, as a necessary precedent to being granted a certificate for payment, receipts and vouchers showing his expenditures for materials and labor including payments to subcontractors. Such a stipulation is proper in case of cost plus contracts but not in case of lump sum contracts in states having mechanics' lien laws or if the contractor has furnished an indemnity bond. In the latter case such a requirement would tend to subvert [illegible] of the work and would constitute an unwarranted interference with the contractor and a violation of his right to run his own business as he sees fit within the law. Such requirements afford no necessary protection to the owner but are often most irksome to the contractor, frequently placing him at the mercy of vindictive or unscrupulous subcontractors and material men.

In view of the fact that some contract forms, notably the standard form of the American Institute of Architects, are cluttered up with attempts to determine what the relations of the general contractor with his subcontractors shall be it may be well again to direct attention to the basic principle of efficiency: that a responsible party must have complete authority within the scope of his responsibility.

After a contractor has accepted responsibility to the owner for the execution of certain work in accordance with certain specifications it is unconscionable even to suggest that the owner or anyone shall have the right to go beyond the specifications in dictating as to how he shall go about the work, what men or subcontractors he may or may not employ, how, when or how much he shall pay them, whence and on what terms he may procure his materials, etc. Lien laws protect labor and generally material dealers and subcontractors as well, with-hold notices or writs of attachment are available for any emergency and the owner's interests are amply protected both by the indemnity bond furnished by the contractor and by the withheld percentage of the contract price. Why provide for placing in the hands of an irresponsible autocrat weapons wherewith to harry the responsible contractor, with probable detriment to the owner's interests?

Much of the foregoing comment is based on a critical examination of the standard "General Conditions of the Contract" adopted by the American Institute of Architects. The writer is familiar with at least one form that in a certain district for many years has satisfactorily covered the points hereinbefore alluded to, and it is safe to say that no new form that fails in this respect would meet with ready favor in that particular district.

E. T. THURSTON,
Secretary General Contractors of San Francisco.
San Francisco, Calif.

How Street Railways Figure Depreciation on Their Motor Trucks

Some interesting information on this subject is given in the January issue of Aera, the official publication of the American Electric Railway Association. The following answers are given to the question: "If motor trucks are used in connection with line or track work, on what basis is their depreciation calculated?"

N. C. Rasmussen, Superintendent, Wisconsin Valley Electric Company, Wausau, Wis.—On a 100,000 mile basis.

F. J. Gannon, Assistant Treasurer, Northern Texas Traction Company, Fort Worth, Texas.—All automobiles owned by this company are pro rated to expense over a period of two years from the date of their purchase.

K. A. George, Auditor, Indiana Railways and Light Company, Kokomo, Ind.—We do not operate motor trucks in connection with railway line or track work. We have eight trucks in our light and power department on which no separate depreciation is figured, that item being included in a blanket charge on the entire property.

A. B. Cleveland, Secretary and Treasurer, Elmira Water, Light and Railroad Company, Elmira, N. Y.—Ten per cent. per year.

B. W. Fernald, Auditor, San Francisco-Oakland Terminal Railways, Oakland, Cal.—The depreciation on motor trucks used in line and track work as well as all other automotive vehicles is calculated on an estimated life for each truck. The salvage which we hope to realize at the expiration of the lives of the vehicles is first deducted and the balance of the cost is pro rated over their lives—a charge being made monthly to operating expense accounts with credit to "Accrued Depreciation Road and Equipment." The lives of vehicles vary considerably, according to their make and the use to which they are to be put. To some of our line trucks we assign a life of ten years, while those used by the Way and Structures Department are assigned a maximum of four years, this on account of the difference in the wear and tear due to usage.

H. C. Kihneman, Jr., Auditor, Shreveport Railways Co., Shreveport, La.—We calculate depreciation on our motor trucks as follows: First year, 15 per cent.; second year, 20 per cent.; third year, 15 per cent., and thereafter 10 per cent.

Economics of Line Revision on Lackawanna R. R.

Reason for Building the Clark's Summit-Hallstead Cut-off—Original Estimates and Actual Results Slightly Condensed from a Paper Presented Before Western Society of Engineers, Dec. 15, 1921

By GEORGE J. RAY
Chief Engineer, Delaware, Lackawanna & Western Railroad

The older portions of the Lackawanna Railroad, like many of the other railroads built through rough country in the early days, were constructed with many sharp curves and heavy grades. The main line crosses the Pocono Mountains at an elevation of approximately 2,000 ft. above sea level. At Scranton, in the center of the anthracite coal fields, where much of the railroad's traffic originates, the elevation of the main track is about 735 ft. above sea level.

General Conditions. The topography of the country in the vicinity of Scranton is such that heavy grades are required for both east and westbound traffic from that point. The lowest available summit westbound is approximately 500 ft. above the tracks at Scranton and is so located that a 1½ per cent grade is necessary from Scranton to this point which is known as Clark's Summit. For 40 miles west of Clark's Summit the old line traversed a very broken country approximately at right angles to the water sheds, with the result that the line was built with heavy grades against both east and westbound movement. These grades consisted of two stretches of uncompensated 65-ft. grade and one 46-ft. grade against eastbound movement, one 21-ft. and one 28-ft. grade against westbound movement.

As the tonnage increased this line became more and more difficult to operate. It will readily be seen that where an engine handled full tonnage, for the line between Hallstead and Elmira, either east or westbound, pusher service was necessary on that part of the line between Hallstead and Clark's Summit. Because of unbalanced traffic, the great variation between the east and westbound pusher grades, and because of a very bad tunnel at one summit east of Nicholson, pusher engines could not be economically used, resulting in very low mileage for the pusher engines. Not only was it necessary to push freight trains both east and west, but it was also necessary to use puller engines on passenger trains eastbound between Nicholson and Clark's Summit.

Through this same territory the old line was very crooked, the total amount of curvature in the 41 miles between Clark's Summit and Hallstead was 3,845 degrees. Four to six degree curves predominated.

Traffic and Operation—Additional Capacity Required.—Figure 1 is a diagram showing the net tons of freight and coal carried per year from 1900 to 1920, inclusive. The broken line represents the actual tonnage carried. The dotted straight line indicates the average increase from 1900 to 1909. This line produced was used as a basis of estimating probable future tonnage.

The old line was expensive to operate and maintain. The heavy tonnage over sharp curves and steep grades caused excessive rail wear and the track was expensive to maintain from every standpoint. In the 40 miles there were twenty-nine public grade crossings, all of which could be eliminated only at a very material expense. The problem to be solved, therefore, was one which required the best possible alignment with grades over which increased tonnage could be handled and at the same time reduce pusher service all possible in both directions. The tonnage had reached such a point that additional main running tracks must soon be built on the heavy grades in order to avoid excessive delay to fast freight and passenger trains due to the long time required for slow freight trains to get over the roads. Additional passing tracks would not solve the trouble and only cause additional delay to slow freight. To build additional tracks along the old alignment would be expensive, and the construction would greatly interfere with traffic. Incidentally the construction of a new line would provide an up-to-date road bed and eliminate all grade crossings.

Limits of Grade and Curvature.—I will not attempt to discuss the preliminary work which was done in order to reach a conclusion as to the proper line to build. Permit me to say, however, that it was an impossibility to locate a new line which would be a big improvement as to curves, grades, etc., without encountering very heavy construction.

We fixed 13 ft. per mile as the maximum grade against westbound movement, in order to eliminate the pusher service westbound and permit full tonnage to be handled west over the entire division. The eastbound pusher grades were determined by actual test on other parts of the line where it was possible for us to pick out a grade on which the required tonnage could be handled with one engine and a pusher. Grades were compensated for curvature by using 3/100 of 1 per cent per degree of curve. This allowance was used for curvature on a change of line made at another point on the road in 1908 and proved to be about the correct allowance.

An Independent Problem—Changing Condition.—After the surveys had been completed and estimates prepared for the various proposed lines, extensive calculations were made to determine the probable saving to be expected in operation and maintenance costs due to the reduction of distance elimination of curvature, rise and fall, and the reduction of gradient. After an extended study of all available information covering the savings in operation to be expected by such a change in line, we came to the conclusion that it was absolutely necessary to work the problem out in a more or less independent way, being governed by the conditions at hand. We concluded that in cases where important improvements had been made on other lines, the conditions to be dealt with were so very different that we could not consistently use the conclusions reached without a very careful examination as to whether or not they were applicable to the case in hand. The natural increase in business, together with the constantly changing conditions in operating, the increased tractive power of locomotives, the increased average car capacity, new legislation and government regulations so change the conditions from time to time that we must necessarily attack all such problems as they are found and not depend too much upon figures which others have made.

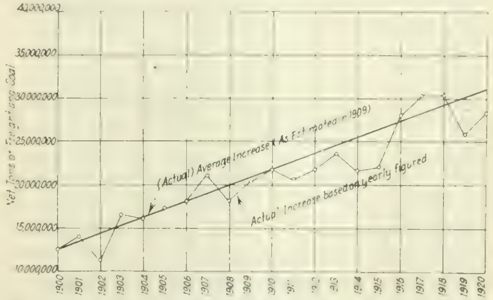


Fig. 1.—Net Tons of Freight and Coal Carried Each Year from 1900 to 1920.

Savings Calculated on Train Miles and Pusher Miles.—Where a reduction in grade is made which will enable an engine to pull a heavier train and thus reduce the number of train miles required to handle a given tonnage, we must arrive at the possible saving due to the elimination of one train. It is evident that the elimination of one train in handling a given tonnage will entirely eliminate certain expenditures such as coal for fuel and wages of enginemen and trainmen. The wear on the rail, ties, ballast, and other track materials, will be less because of the eliminating engine. On the other hand, such items of expense as superintendence, cost of traffic department, floating equipment, etc., will in no way be reduced by the change.

In like manner the reduction of one mile in distance will eliminate one train mile for every train run; hence, we must calculate the probable saving due to the elimination of one mile in distance. It is also evident that the cost of maintaining one mile of track is eliminated and likewise the trainmen's wages.

pusher engines our problem is to calculate the saving due to the elimination of one pusher mile.

Wear as Related to Total Curvature and Degree of Curve. The total value of reducing curvature cannot be readily reduced to a basis of dollars and cents, but some features of the value of curve reduction such as rail wear can be fairly accurately determined. It is easy to determine the average life of main track rail for that part of the railroad over which the traffic is fairly uniform. The rail records also furnish the necessary data to compare the rail wear due to curvature with that on straight line or as between light curves and sharp ones. In a general way the amount of rail wear due to curvature in any given territory depends upon the total curvature and not so much on the degree of the curves. In other words, the total rail wear due to 30° of central angle in a mile of level track will be about the same whether the curvature consists of 500 ft. of 6° curve or 3,000 ft. of 1° curve. What is true with respect to rail wear is also more

Where the grade is reduced so as to reduce the number of

or less true with all other items of roadway expense effected by the elimination of curvature. Damage to equipment, and loss and damage to freight due to curvature is greater with sharp curves, but in general the additional wear on rolling stock due to curvature depends, like the track, on the total degrees of curvature and not on the degree of the curves.

Since all items of the accounts making up operating expenses are based on the average alignment (in the case under consideration 0° 50′) for convenience the estimated savings due to elimination of curvature are based on the comparison of a mile of 5° curve and the same amount of 0° 50′ curve.

In the preliminary location of the new line an effort was made to keep the maximum degree of curvature down to 2°. No effort was made to place a value on the reduction of the maximum degree of curvature from five or six degrees to two degrees. As a mater of fact much is gained in speed and safety of operation, and in location work due consideration must always be given to this important feature of the alignment. In the construction of the new line 2,179 degrees of curvature were eliminated.

Rise and Fall.—The elimination of rise and fall will reduce the cost of operating a given train over the road. In estimating the savings to be expected by eliminating rise and fall we have considered that the resistance on a 0.5% grade is just double the resistance on straight level track. Therefore, an engine would have to overcome the same resistance in pulling a load up a 0.5% grade a mile long as it would on a two-mile stretch of level track. It is easy to see that it will cost something to move the train from the hump a mile down a 0.5% grade.

Train Miles and Operating Expense.—In all the calculations we have based our figures on the total cost per train mile including all expenses in connection with the operation of the railroad, except general expenses. In 1909 we bunched the passenger and freight trains to get the total revenue train mileage for the year, and thus secured a composite cost per mile for passenger and freight. At the time this work was done, charges were not being allocated as between passenger and freight service, hence a composite figure had to be used. Work train mileage was excluded but the expense was included in the total cost. I know of no accurate way to figure the cost per train for any given part of the railroad as the accounts are never kept in such a way as to determine a proper allocation for a specific section of the line such as that under consideration, hence, it is necessary to include the total cost of operating the railroad, figure the percentage that each item of the account bears to the total, then estimate the percentage that each item is affected, if at all, by the changes under consideration. This method of figuring is at least on the safe side as the cost per train mile on the section of line under consideration was certainly above the average.

In Table I will be found our estimate of the per cent that each item of the account will be affected. First: By a reduction in grade such as to permit the same tonnage to be handled with one less train. Second: By the elimination of one mile distance. Third: By a change in grade which will permit the elimination of one helper engine. Fourth: By a reduction of one mile of 5° curve to the average curvature of 0° 50′. At the foot of this table the total cost per train mile for the year 1920 is shown as $6.02. This amount is found by dividing the total operating expense for the year 1920 by the total revenue train miles. A division of the charges as between passenger and freight for the year 1920, as reported to the Interstate Commerce Commission, shows the total cost per passenger train mile of $3.28 and per freight train mile of $8.77.

Savings to Be Expected. In regard to the per cent that the various items of expenditure will be affected by the addition or elimination of one train in handling a given business, and as indicated in Table I, I desire to make the following explanation with reference to some of the main items.

In the first place passenger trains are not affected, except that they can make better time and the puller engines (which are included under helper engines) will not be required. The same number of passenger trains are run as before the change.

Prior to discussing the percentages that various accounts are affected by the changes under consideration as shown in

TABLE I—EFFECT ON MAINTENANCE AND OPERATING EXPENSE DUE TO CHANGES IN GRADE, CURVATURE, DISTANCE, AND RISE AND FALL

Note.—Figures for grade are based on the addition or elimination of one train in handling a given business. Figures for distance are based on the elimination of one mile. Figures for helper engines are based on the elimination of one helper mile. Figures for curvature are based on one mile of 5 degree curve compared with the average curvature of 50 seconds. Figures for rise and fall are based on the comparison between 2 miles of level tangent track and 2 miles of tangent track with a hump of 26.4 ft. in the middle. While the elimination of rise and fall will slightly affect track maintenance, locomotive and car repairs, etc.; the main item affected, and the only one amounting to a considerable saving, is reduction in fuel, water and lubrication for locomotives. These items would be affected approximately 50%, or 5.31%—say 5%—of the cost of $6.02 per train mile. This equals $0.30 saving per train mile.

[The table shows maintenance and operating expenses of the entire road for the year 1920 by standard accounts from No. 201 to No. 442. Here we show only six of these accounts for purposes of illustration, together with the total on which final calculations are based.—Editor, Engineering and Contracting.]

Account No.	Item	Maintenance and operating expenses.	Grade: Per cent of total	Grade: Per cent affected	Grade: Per cent cost per train mile	Distance: Per cent affected	Distance: Per cent cost per train mile	Helper: Per cent affected	Helper: Per cent cost per train mile	Curvature: Per cent affected.	Curvature: Per cent cost per train mile
201	Superintendence	$ [illegible]	[illegible]	.					...	...	.....
221	Right of way fences	[illegible]	0.08	.		100	0.08	.	...	...	.....
271	[illegible]	79,17[illegible]	0.0[illegible]	...					.	..	.
314	Freight train car repairs	5,726,[illegible]	[illegible]	.		[illegible]	[illegible]			20	1.57
394	Fuel for train locomotives	8,17[illegible]	11.10	100	11.10	[illegible]	[illegible]	60	6.66	25	2.78
418	Loss and damage—freight	[illegible]	1.73	15	0.26	[illegible]	[illegible]			10	0.17
	Total	$71,921,87[illegible]	100.00	.	28.42		48.07	.	19.84	..	17.29

Total passenger train miles 5,600,540
Total freight train miles 6,344,882

Total 11,945,422

Cost per train mile $71,9[illegible] / 11,945,[illegible] = $6.02

Cost per freight train mile for 1920 $8.77 as reported to I. C. C.
Cost per passenger train mile for 1920 $3.28 as reported to I. C. C.

	Grade	Distance	Helper	Curvature
Per cent cost per train mile			19.84%	.
Cost per train mile			$6.02	.
Product			$1.194	...
Interest charge			0.065	.
Saving per mile	.		$1.259	...
Per cent cost per train mile	28.42%	48.07%		17.29%
Cost per passenger train mile	$3.28	$3.28		$3.28
Product	$0.932	$1.577		$0.567
Interest charge	0.057	0.073		0.000
Saving per train mile	$0.989	$1.650		$0.567
Per cent cost per freight mile	28.42%	48.07%		17.29%
Cost per freight train mile	$8.77	$8.77		$8.77
Product	$2.492	$4.216		$1.516
Interest charge	0.057	0.073	.	0.000
Saving per train mile	$2.549	$4.289	.....	$1.516

Table I, I wish to say that I have found it advisable to make some changes in the percentages as originally shown and the savings to be expected have been figured on the estimates for 1920, on the revised figures.

Savings Through Elimination of Grade.—Account 212—Ties will be affected about 12% by the elimination of one train, on the basis that the engines do approximately 20% of the mechanical destruction to ties by traffic. This would not necessarily be a fact where ties are not treated, but in the case under consideration all ties are treated and protected with heavy tie plates. Since the per cent of road freight engines to the total number of engines is approximately 60% the ties would be affected about 12% by the elimination of one train.

Account 214—Rails; Account 216—Other Track Materials, and Account 218—Ballast, will likewise be affected about 12%. It is thought by those best qualified to know that many heavily loaded freight cars with small diameter wheels do more damage to rails and the rest of the track structure than the engines although the latter have much heavier wheel loads. On one part of the Lackawanna where we have many passenger trains, both local and through, with engines as heavy as those operating on the main line, but with little or no freight service, we find the tracks comparatively easy to maintain compared with other parts of the line where both passenger and heavy freight trains are handled. What is true with respect to the track is likewise apt to be true with respect to equipment. Originally I placed a higher percentage on the effect of eliminating the engine than I now believe warranted. As a result I have fixed 20% as a fair amount for rail, ties, other track materials and ballast. Since only 60% of the power is used in road freight service the above percentage is reduced to twelve.

Account 249—Signals and interlockers. Thirty-one per cent is allowed for this account on the ground that about 50% of the expense of maintaining signals and interlocking is directly due to train movements. The life of an automatic signal depends upon its use. The cost of maintenance increases with the number of train movements and as the train movements increase the signals must be placed closer together.

Accounts 308, 309 and 310—Steam locomotive repairs, depreciation and retirements will be affected about 62%, this being the ratio that road freight engines bear to the total engines in service.

Account 392—Train enginemen affected about 74%, this being the ratio of the freight train enginemen to the total.

Accounts 394, 397, 398 and 399—Fuel, water, lubricants and other supplies for train locomotives. These items are made 100% on the ground that the reduction in grade entirely eliminating the freight locomotive will also make a marked decrease in the amount of coal, water, etc., consumed by the passenger locomotives.

Account 400—Enginehouse expenses train. This account will be affected 100%.

Account 401—Trainmen will be affected 69% or the ratio that the wages of freight trainmen bear to the wages of all trainmen.

Savings Through Elimination of Distance.—The amount that the various accounts are affected by the elimination of one mile in distance:

Account 405—Crossing protection. If the charges to this account were uniform over the entire road, this item would be affected 100%. As a matter of fact it cannot be so considered. The saving in connection with the elimination of crossings has been considered as a separate item.

Account 202, roadway maintenance; 208, bridges, trestles and culverts; 212, ties; 214, rails; 216, other track materials, and 218, ballast; all the track laying and surfacing subdivisions, roadway buildings and damage to live stock on right-of-way will be affected 100%. These items will be entirely eliminated.

Account 249—Signals and interlockers will be affected 50% on the ground that the automatic signals will be eliminated, but the number of interlocking plants will not be affected.

Accounts 308, 309, 310—Steam locomotive repairs, depreciation and retirements. These items will be affected 80% for the reason that 80% of all locomotives are in road service.

Accounts 314, 315, 316—Freight train car repairs, depreciation and retirements will be affected 65% based on an estimate that 65% of all repairs are due to road service.

In like manner Accounts 317, 318 and 319, passenger train car repairs, depreciation and retirements, will be affected 75%.

Accounts 392 and 401—Train enginemen and trainmen will be affected 95% on the basis that 5% of the total expenditure is made up of constructive mileage.

Accounts 394, 397, 398 and 399—Fuel, water, lubricants and other locomotive supplies will be affected 90% on the basis that 10% of the expenditure is due to supplies paid for while trains are standing on the sidetracks, stations, etc.

Account 400—Enginehouse expenses (train) will be affected 100%.

Savings in Helper Engines.—Assuming that one-half the pusher mileage is light and that a light engine will do one-half as much damage to track and to itself as it will do when handling tonnage, we can apply 75% to all the items of roadway maintenance and maintenance of equipment which will be affected by a change in grade as shown under Column 4, Table I.

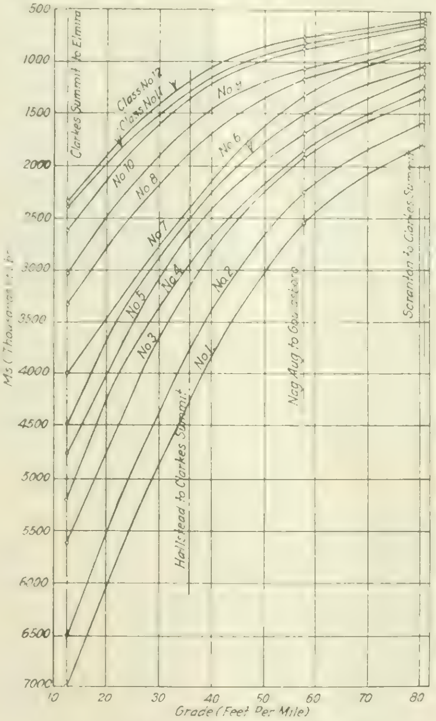


Fig. 2.—Engine Ratings Used in Calculations.

Account 392—Train enginemen will be affected 74%, this being the ratio of freight enginemen expense to the total expense of train enginemen.

Accounts 394 and 397—Fuel and water will be affected about 60% owing to the fact that the engines are running light part of the time.

Accounts 398, 399 and 400—Lubricants, other supplies for train locomotives and enginehouse expense (train) will be affected 100%.

Account 401—Trainmen will be affected about 25% since only one trainman is required for each pusher. As a matter of fact at the present time trainmen are not used on pusher engines.

Savings Through Elimination of Curvature.—Account 212—Ties are affected 50% on the basis that a better grade of tie is required on a 5° curve than on a straight track, costing in the neighborhood of 25% more money. Further more, the life of ties on straight track is approximately 30% longer than on a 5° curve.

Account 214—Rails are affected 400% based upon records of rail renewal. Ten years ago we put in service the new line known as the Lackawanna Railroad of New Jersey. The maximum curvature on this line is 2°, one-third of the line was laid with 91-lb. D. L. & W. section rail, the remainder with 101-lb rail. All ties were treated with creosote and protected with flat bottom screw spike tie plates. This year the 91-lb rail after ten years of service, was relaid. A small part of the 101-lb rail will be relaid next year and it is safe to say that the average life of the rail in the line will be eleven and one-half years. The life of rail on 5° curves on other parts of the road carrying the same traffic does not average more than 2½ years. On the Lackawanna Railroad of New Jersey after ten years of service, approximately 195,000 ties out of a total placed of 200,000 are still in service. Most of the 5,000 ties removed were again used in yard tracks as they were not decayed but badly cut on the 2° curves.

Account 216—Other track material is affected 200% or one half that applied to rail on a basis that new bars, bolts and spikes are required when rail is relaid, whereas the same tie-plates can be continued in service.

Account 218—Ballast is affected 30% on account of increased amount of ballast being required to form a shoulder and to provide for the elevation. There is also a greater wear on the ballast and consequently a shorter life on account of necessary additional tamping.

Account 220—Track laying and surfacing is affected 100%, this being a fair average of the percentage applied to ties, rails, ballast, etc.

Accounts 308, 309 and 310—Steam locomotive repairs, depreciation and retirement are affected 30% on the basis that 15% of the cost of engine repairs and renewals is chargeable to drivers and ties and this expense will be at least twice as much on a 5° curve as on the average alignment.

Accounts 314, 315, 316, 317, 318 and 319, Freight and Passenger Car Repairs Depreciation and Retirements will be affected 20 per cent.

Savings Through Elimination of Rise and Fall.—While several items of the accounts will be affected in a slight manner by rise and fall, the only one that amounts to any considerable sum is that of Fuel for Locomotives. We have considered this item as 50 per cent affected due to the fact that there is considerable loss when the engine is working at low efficiency while pulling a heavy load, say, at 10 miles per hour, also a loss due to poor combustion at low speed. A very considerable increased amount of coal is necessary where engines are operating at low rates of speed. Furthermore, more steam is consumed and more or less energy wasted in braking down the train on descending grades.

TABLE II. ESTIMATED SAVINGS OF CLARKS-SUMMIT-HALSTEAD CUT-OFF BASED ON TRAFFIC OF 1920. ESTIMATED IN 1910.

Savings due to grade reduction—		
Slow freight 1044[illegible]x61x.75		$ 321,306.75
Fast freight [illegible]x.75		66,631.50
Fast freight [illegible]x61x.75 Binghamton to Elmira		23,811.75
Savings due to distance eliminated—		
[illegible]x61		157,251.03
Savings due to curvature eliminated—		
[illegible]x.4		114,190.56
Savings due to rise and fall eliminated—		
[illegible]x61 divided by 26.4		81,550.00
Savings due to pusher miles eliminated—		
[illegible]x.61		102,871.01
31742x.61, light engines Binghamton to Elmira		19,362.62
Total savings		$ 889,978.22
Savings capitalized at 4%		$22,249,455.50
Total cost of new line	$14,259,340.21	
Less credits account elimination of grade crossings, credits [illegible] third track along old line, value of salvage old line, etc.	1,905,900.00	
		12,353,440.21
Net gain		$ 9,896,015.29

TABLE III. SUMMARY OF SAVINGS BASED ON ACTUAL COST OF HANDLING 1920 TRAFFIC OVER THE CUT-OFF AND ESTIMATED COST OF HANDLING THE SAME TONNAGE OVER THE OLD LINE

Savings due to grade reduction—		
Slow freight [illegible]		$ [illegible]
Fast freight [illegible]x61x2.549		154,556.10
Fast freight [illegible] Binghamton to Elmira		[illegible]
Savings due to distance eliminated—		
Freight [illegible]		[illegible]
Passenger [illegible]		[illegible]
Savings due to curvature eliminated—		
Freight [illegible]		[illegible]
Passenger [illegible]		[illegible]
Savings due to pusher miles eliminated—		
[illegible]		[illegible]
[illegible]		[illegible]
Savings due to rise and fall eliminated [illegible] divided by 26.4		[illegible]
Total savings		[illegible]
Savings capitalized at 4%		[illegible]
Total cost of new line	[illegible]	
Less [illegible]		
[illegible]	[illegible]	
		[illegible]
Net gain		[illegible]

Note: [illegible] as figured in 1908 [illegible]

Summary of Savings to Be Expected.—In order to apply the total percentages arrived at and as shown in detail in Table I, it is necessary to estimate the number of trains which would be required to handle the 1908 business over the proposed new line and thus determine the total train miles saved per annum on account of reduced grades. It is likewise necessary to determine the number of pusher engine miles saved.

The total number of train miles saved on account of reduction in distance is found by taking the sum of all revenue trains in both directions and multiplying this by the number of miles the distance is reduced.

In figuring the total amount saved on account of eliminating curvature, the total reduction of curavture is reduced to miles of 5° curve. The result in miles is multiplied by the total number of trains per annum.

Comparison of Original Estimate and Actual Result.—In Tables II and III will be found the estimated savings for the Clark's Summit-Hallstead Cut-Off as compared with the old line based upon the traffic of 1920 as estimated in 1910 and the actual traffic for 1920. The savings here shown as estimated for 1920 are exactly as figured in 1910. I have heretofore stated that I have revised some of the percentages for the various operating expenses.

The total savings figured on 1908 business is $365,284.04. This saving capitalized at 4 per cent is $9,132,101. The actual cost of constructing the line was $14,259,340.21. This amount can be reduced by one million dollars for the cost of eliminating the grade crossings which would have been necessary had the old line been retained; and as a matter of fact, had the old line remained, it would today be costing the interest on a million dollars for the crossing protection which was necessary at the time the line was abandoned. The cost of building a third track on the old line together with the credits for rail amounted to $905,900, making a total credit of $1,905,900. Therefore, the net savings to be expected based on 1908 business would fall short of building the new line by about $3,221,339.

One very material advantage of the new line which we have not attempted to estimate in dollars and cents is the reduced time required for freight trains on the division, thus materially assisting to keep down the overtime. This feature is a very important one at the present time when overtime is being paid at the rate of time and one-half.

While the new line cost somewhat more than was originally estimated, it was not anticipated that a four-track railroad would be built over any portion of the line and a third track was only provided on the heavy grades. A very material change was also made at Clarks Summit where westbound slow trains pass under the main tracks in order to avoid crossing these tracks at grade at the Summit as was the practice on the old line.

The year 1920 cannot be considered a safe year as a basis for computing transportation costs. Nevertheless our figures indicate that there would still be a wide margin in favor of the new line if the cost per train mile should be cut in two, to say nothing of increased traffic in the future.

In concluding, I wish to give full credit to Division Engineers Doughty and Tallyn, who worked with me in all the computations and deserve much credit for the vast amount of work which was necessary in order to reach the conclusions. Also to Mr. Wheaton, now Division Engineer of the Buffalo Division, who had direct charge of the construction work. It is only fair to state that the early discussions of this subject by Wellington and later by Mr. Barry in his paper to the American Railway Engineers' Association, were referred to and studied in great detail.

Railways Bureau Formed by Portland Cement Association.

The Portland Cement Association has just organized a railways bureau at its general office in Chicago. This new bureau will facilitate service available to railroad men through the resources of the Portland Cement Association for compiling and presenting authoritative data on railroad uses of concrete. D. A. Tomlinson is manager of the bureau.

Motor Truck Haulage on 750,000 Cubic Yds. Rock Excavation Job

A fleet of 20 motor trucks is being engaged by the Read-Coddington Engineering Co. on its contract for the $8,500,000 power extension development of the Niagara Falls Power Co. of Niagara Falls, N. Y. The work includes the excavation and hauling of nearly 750,000 yd. of rock.

The project calls for a 4,300-ft. tunnel to convey water from Niagara River above the falls to the company's power house. A fan-shaped inlet sloping to a depth of 70 ft., and a rectangular outlet, or forebay, 80 ft. deep are at either end of the tunnel. Trisecting the tunnel are two shafts, 10 ft. wide, 30 ft. long and 145 ft. deep. These units—the inlet, the outlet and the tunnel—are being blasted out of solid limestone.

Excavation was started April 25, 1921, on the outlet, where 60,000 cu. yd., place measurement, are being removed. At the end of six months about 45,000 cu. yd. had been excavated. In the meantime, the two tunnel shafts and the inlet excavations were under way. An average of 10 trucks served the shovel and cranes at the outlet, the remainder of the fleet being used at the other points.

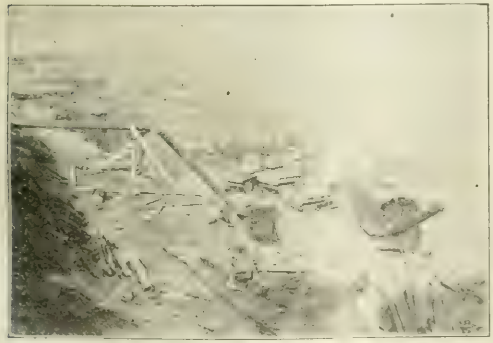
It was soon found that at the speed with which the trucks operated, the steam shovel could serve as high as twelve trucks, although at times only ten were used. The haul is 2 miles. Each truck makes from 11 to 13 trips a day, so that an average of 135 or 140 loads are removed daily. About two solid yards are loaded each time.

The trucks are Pierce-Arrow 5-ton dual-valve trucks, equipped with 4-yd. dump bodies with new horizontal type of power hoist.

Steel bodies are being used, and to brace them against the shock of loading, 35-lb. steel rails—four in number—were fastened to the bed of the bodies. The steel rails likewise facilitate dumping, the load sliding off from them easily.

Operation soon revealed several practical features which speeded up the truck work. For instance, tail gates were dispensed with, for it was found that a full load could be carried by piling it at the forward end of the body. Thus no time is lost in fastening or unfastening the tail gate locks. Moreover, the steam shovel operator works with greater freedom, for there is no danger of damaging the tail gates with the shovel.

Another arrangement that has resulted in an economy of time and fuel is the method used in constructing the incline. To climb out of the pit the trucks ascend a short ramp which has a grade of 20 per cent. This is done, of course, in low gear. For a short distance, the climb is one of 12 per cent which levels out for 30 ft. into a grade of only a few per cent. This gives the driver ample opportunity to shift from low to second gear preparatory to the final 250-ft. climb of 10 per cent. In other words, a "gear-shift level" enables the trucks to gain headway sufficient to make a faster ascent with a smaller expenditure of fuel.



The truck on the incline leading out of the outlet excavation is halfway up the 12 per cent grade which leads onto "this level spot" shown in the extreme left of the picture. On this level the drive shifts into a higher gear to make a more rapid and economical ascent of the 10 per cent grade which completes the truck's ascent.

To keep the trucks in adjustment and to facilitate emergency repairs, a chief mechanic and assistants are employed. Close attention is given to lubrication, it being the sole duty of one man to grease and oil the chassis systematically.

At the inlet the work is being done behind a coffer dam which locks out the river. About 50,000 cu. yd. of limestone, place measurement, are being removed.

A group of four or five trucks is employed on the shafts which will pierce the tunnel. These trucks are worked double shifts most of the time. From the two shafts about 3,000 cu. yd. of material are being removed. The material is hoisted in a bucket which drops a full load into a truck.

All the material from the tunnel likewise will be hoisted through the shafts with the exception of that which is being blasted from the tunnel intake and outlet. The intake and outlet are bell-shaped, narrowing from a diameter of 50 ft. to 36 ft., excavation measurements. The actual diameter of the tunnel when lined will be 32 ft.

During noon hour the surface of the outlet incline is frequently touched up. A load of screenings is being dumped. The grade at the extreme right of the picture, where a sharp turn is made, is 20 per cent for a short distance. The picture also shows how the truck bodies are reinforced with steel rail.

Record Construction Activity in December

December building contracts in the 27 Northeastern States of the country, as reported by the F. W. Dodge Co., amounted to more than for any previous December, with the exception of December, 1919. The total amount of these contracts was $198,518,000, an increase of 3 per cent over the November figure, whereas December usually shows a decline from November. The closing month of 1921 showed an increase of 98 per cent over the corresponding month of 1920. The total amount of construction contracts let during 1921 was $2,359,018,000, only 8 per cent under the 1920 total. The predominating factor in the year's program was residential building, which amounted to $880,052,000, which was 37 per cent of the 1921 total, and represented an increase of 54 per cent over 1920 residential construction. Public works and utilities took second place, amounting to $459,148,000, or 19 per cent of the year's total. Other important items were: Business buildings, $336,920,000, or 14 per cent; educational buildings, $242,562,000, or 10 per cent (this figure representing a very considerable increase in a number of projects and in total value over 1920); and industrial buildings, $173,325,000, or 7 per cent of the year's total.

Detection of Leakage from Air Lines.—In co-operation with a shipyard where oxygen gas used for cutting and welding is distributed under pressure through a long system of pipes, tests have been made by the U. S. Bureau of Mines to determine the feasibility of using a stench for detecting and eliminating leakage of the expensive oxygen. It was recommended that a stench such as thyl mercaptan, amyl acetate, or phenyl isocyanide be applied in the distributing line at a pressure of 30 lb., sagreater danger of ignition or explosion exists if application is made in the high-pressure line at the compressors. In experimental tests, on stench-warning systems recently installed on compressed-air lines at various metal mines, the warnings have been distributed among distant workings in 2½ to 10 minutes, but no occasion has occurred thus far for using a stench for a necessary warning.

Methods of Lining St. Paul Pass Tunnel of C. M. & St. P. Ry.

One of the most interesting features on the Puget Sound extension of the Chicago, Milwaukee & St. Paul Ry. is the St. Paul Pass tunnel at the summit of the Bitter Root Mountains on the boundary line between Montana and Idaho. This tunnel is 8,771 ft. long, and with the exception of 1,300 ft. of [illegible], was timber lined. The construction started with the driving of the heading at the east portal on Jan. 8, 1907, and at the west portal on Aug. 12, 1907. The last bench was begun in September, 1907 and the west bench in January, 1908. The headings met on Feb. 9, 1909, at Station 37+11 and the benches on March 4, 1909 at Station 43+24. Shortly after the completion of the tunnel the two portals and five short interior sections, amounting in all to 753 ft., were lined with concrete. This concreting was done between July, 1909, and October, 1910. Five years later the railway began lining the remaining 8,018 ft. of tunnel. An interesting account of how the concreting was handled was given by C. F. Urbutt and S. H. George in a paper presented Oct. 19 at the annual meeting of the American Railway Bridge and Building Association. An abstract of the paper follows.

The lining was started on June 20, 1915, and completed on Dec. 8, 1916. Grouting was started with one car on Sept. 30, 1916, a second car started on Oct. 18, 1916, and a third car started on Oct. 30, 1916. The work was completed on Feb. 10, 1917.

Construction Camps Located at Tunnel Portals.—The east portal was on a comparatively flat hillside and there was sufficient room for the erection of the plant and camp. The most serious obstacle was the handling of a snow water creek that discharged just above the portal and made necessary the construction of a flume to handle the water to permit the efficient handling of the equipment situated under the snow shed at the portal.

The topography adjacent to the west portal was bad, being on a steep mountain side and with an approach cut that materially hampered the installation of material handling equipment and caused many delays by being easily blocked with snow during the winter months. The west portal of the tunnel is about 400 ft. in an approach cut. The camp site was located over the side of a side-hill fill, making it necessary to support the camp buildings, bunkhouses, dining room, etc., on bents, some exceeding 50 ft. in height. The power plant was located about 1,500 ft. from the portal and on the up-hill side of the tracks.

From the apex of the grade at the summit at about the center of the tunnel the grade sloped both ways on 0.2 per cent to each portal. The tunnel is on tangent except for 470 ft. of 10 deg. curve at the west end and a 10 deg. approach curve 244 ft. long through the snow shed at the east end. The tunnel is single track.

Condition of Old Timber Lining. When the tunnel was driven in 1907-1909 all except 1,300 ft. about 1,000 ft. from the west portal was timber lined, full lagged and packed, as there was considerable overbreak due to the fact that the slate cut at a 30 deg. dip to the horizontal and was interbedded with [illegible] talc seams. During the intervening years some of the timber was displaced slightly by pressure from swelling and as the tunnel was very wet steps had to be taken to dry the roof to permit electrification. That primarily was the cause for starting the work, although a few years more would have made concrete lining necessary on account of the condition of the timbering. As the work proceeded, a close inspection was made of the untimbered section and it was decided to concrete the roof, supporting the arch on a system of columns and girders. The roof was concreted to prevent falls of small stones which were loosened by [illegible] and fell due to the dip of the formation described before.

There was a deposit of natural gravel suitable for concrete purposes within 100 miles, cement mills were located within 500 miles, and lumber within 100 miles. Owing to these facts and to the general convenience of handling these materials, concrete lining was considered the most economical and permitted the greatest amount of speed in completing the work.

The original timbering was set for an 18 ft. 6 in. section and the concrete section was made 16 ft. 6 in. wide, allowing one foot in front of the timbers with three feet between the timber sets, which were on four foot centers. To strengthen the section at the connection with the footings a slight narrowing was made between Stations 9+08 and 85+05. Due to the fact that some of the timbers were pressed towards the center slightly at both ends of the tunnel a section 18 ft. wide was used to prevent cutting the timber to excessive thinness and also to give a full foot in front of the timber. This section was used between the east portal and Station 9+08 and between the west portal and Station 85+05. The formation in the untimbered section permitted the fall of small stones and a roof section was all that was needed to prevent these falls. A full section would have taken considerable concrete, would have slowed up the completion of the work, and in addition would have added much to the total cost of the project. It was decided to construct a series of columns and reinforced concrete girders to support the roof. The limit loads on the columns and girders were considered as existing at the time the arch was completed and concrete green. After the concrete was set it was figured that the irregularities of the roof would furnish sufficient bearing to hold the load.

Traffic Through the Tunnel.—Traffic through the tunnel was heavy and although continuous operation was attempted the machines worked but 28 per cent of the time. All locomotives passing through the tunnel were oil-burning and much trouble was experienced and delays suffered, due to the fact that the tunnel did not clear well and the gas C. O. caused by incomplete combustion of the oil often caused a cessation of the work, as the men were unable to stand up under the air conditions. The tunnel cleared well on clear days, air going to the east in the morning and to the west in the afternoon, this being caused by the sun striking and warming the air on the east slope in the morning and the west slope in the afternoon. During rain or snow storms the air would drift back and forth, following the movement of trains, but the tunnel would not clear entirely. A system of ventilation was tried out, but with the power available the effects were not noticeable beyond a thousand feet from the portal, and the results obtained cannot be considered satisfactory.

Water Supply and Light for the Construction Plant.—The topography at the west portal was such that the plant was spread out and located on a side hill with little or no room for the storage of construction materials. A water supply was obtained from creeks running over the portals at both the east and west ends. The water was melted snow, especially suited for boiler and domestic purposes, and sufficient pressure was obtained by building small dams some distances above the portals and conveying the water to the camps by pipe lines. Water for the mixers was obtained from the tunnel ditches and as there was a discharge of over a second foot there was always sufficient water available.

Light was furnished by a generator in the power house, 75 k. w. d. c. 500-volt with a split circuit, so that the voltage in the tunnel and camps was 250. Considerable trouble was experienced in maintaining the lights in the tunnel due to short circuits caused by excessive water and to breaks caused by moving forms, etc. On clear days the lighting system, which consisted of 60-watt lamps every 20 ft., was very effective, the usefulness being in direct ratio to the amount of smoke and steam in the tunnel.

Little or no time was lost due to crowding ground. Places that were crowding were bled in advance of the lining work and were considered as of regular section when the lining reached that point. The roof pressure between Station 43+70 and 44+06 and between Stations 58+75 and 59+27 necessitated the removal of 47 sets of arch segment timbers and 33 extra sidewall posts and the placing of 34 steel arches, each designed to fit its location from field measurements.

As the equipment was stored on sidings below the camp and men invariably rode the mixer trains in and out, not much time was lost due to going and coming from camp. Carpenters and helpers working on the forms used about 15 minutes on each of the in and out bound trips when walking. During the season of 1916-17 the last snow storm occurred on June 20 and the first on Aug. 28, and during the month of February there was snow to the level height of 16 ft. around the camp and portals. This made it necessary to clear the tracks daily for the rotary plows, and to cut retreats in the snow banks to permit men to walk the tracks and have a place to get in the clear of trains. During the winter months.

it was often necessary to stop work on the tunnel and put all men to handling snow to free equipment and keep the road open for traffic.

How the Aggregate Was Handled.—All concrete aggregate was bank run gravel from Frenchtown. Most Gravel loaded late in the season and covered by rain or snow in transit arrived at the tunnel in a frozen condition. It was thawed by steam points and transferred to a storage bin or pile, both of which had a system of steam pipes to keep the gravel warm. Regardless of this fact, delays on account of the loading of frozen material were frequent. Temperature extremes were great, very dry and hot in the summer and cold with high winds and 30° below zero in the winter.

About 300 ft. from the west portal and on the south side of the track there was placed a guy derrick with a 66 ft. boom. This operated across the main line, unloading gravel cars to the material bin located on a side track just north of the main line or to the gravel storage pile located on the side hill south of the track between the derrick and the portal. The clamshell bucket used with the guy derrick was of three-quarter yard capacity and could unload a maximum of 20 Haskell and Barker cars per day. The crew on this unloading outfit consisted of an engineer who handled the clamshell bucket and the swinging of the boom with a Dake swinging gear, and two men in the cars who cleaned the cars as the unloading progressed. The material bin was built over the side track and at an elevation sufficiently high to permit of the passing of the hopper cars beneath it for loading, and also to permit the movement of ordinary box cars loaded with lumber and cement. The bin had a capacity of 200 cu. yd. with a hopper bottom sloping to two slide gate discharge openings. The sides of the bin were piped for steam heat and this was used during cold weather, steam being supplied by a hoisting engine boiler set up near the bin.

Concreting the Footing.—In the rock section where no timbering was necessary and the roof was lined as previously stated, the standard section footing was used. The water was cut across the tunnel and the section cleared to rock. The forms were placed with column templates and concrete poured. The footing contained a gutter section. Where the tunnel was timbered the excavation was carried to rock in front of the timbers and where possible the space back of the sill was cleaned. The forms were then set and concrete poured. In case of side pressure and struts, the footing was placed in small sections and the strut and footing sections poured together. Where there was a slight pressure but not considered sufficient to warrant struts, temporary timber struts were placed between the sills, the entire section was poured and the timber was cut off at the face of the footing when the concrete had set. The rock bottom was rough and there was sufficient bond between the concrete and the rock to prevent any slip of the footing after the concrete had set. Footings were built ahead of the rest of the work. The top of the footing was keyed and dowelled for the side walls and the part projecting beyond the face of the side wall was faced and made smooth to grade and was used for moving and placing the section forms. No inverts were considered necessary.

Car Mixer Plant.—For concreting the footings and the side walls up to about 4 ft. above the spring line a mixer was designed in the Chicago office. This machine worked very successfully and it was possible to get material to the machine by attaching not over two hopper cars. The footing and side wall machine usually consisted of the mixer and two hopper cars, and as a rule there was not sufficient time between trains to use all of the material loaded. Cement was loaded on a car in front of the mixer from a storage house outside the tunnel during the time the outfit was outside waiting for trains to pass through the tunnel. This machine, called the "side wall machine," is shown in one of the photographs, one of the gravel hopper cars appearing at the left and the cement car at the right.

The arch was concreted by a high car built on the job. An ordinary mixer housed on a flat car with a hoist that carried the concrete to the top of the car, where it was dumped and shoveled into the arch. Full section lagging was used up to the key when three-foot sections were used and concrete rammed in place.

The building housing the power plant at the west end at Roland, Idaho, was of wooden frame lined with sheet iron and erected from material used on a power house on Snoqualmie tunnel. Four 125-horsepower locomotive type oil burning boilers were installed together with four air compressors—2 Laidlow Dunn Gordon duplex, each 1,030 cu. ft. per min.; 1 Ingersoll Rand straight line 525 cu. ft. per min., and 1 75 k. w. Generator, D. C. 500 volt.

The power plant at the east end at East Portal, Mont., contained one 125-horsepower locomotive type oil burning boiler and one Ingersoll Rand straight line air compressor, with a capacity of 525 cu. ft. per min.

The plant was under continuous operation and caused little or no trouble; water conditions were ideal and the mechanical condition of the equipment was good throughout the work.

Tunnel Lining With Pneumatic Mixer.—The lining of the tunnel at either end and of 1,300 ft. of the rock section of the arch was placed by air, a type A pneumatic mixer, purchased from the Pneumatic Placing Co. of New York being used. This mixer was first located at the Roland end of the tunnel and after 1,074 ft. of the west end had been lined, it was removed to the east portal, from which set-up 1,089.5 ft. of the east end was lined. The plant was located as near the portals as possible in both cases. After the ends had been lined this mixer was installed on a specially designed car, and used to concrete the arch in 1,300 ft. of rock section. The conveyor pipe was 8 in. in diameter, connected with 8-hole bolted flanges screwed to the pipe. This pipe was laid along the floor of the tunnel just inside the gutter line and was carried up to the roof and over to the center line of the tunnel by means of three short pieces of pipe and four 45-deg. elbows. These elbows were subject to a great deal of wear and it was necessary to renew them frequently. A great deal of difficulty was experienced with the elbow flanges. The impact of the concrete against the elbow caused these flanges to crack, necessitating the use of extra heavy hydraulic flanges for the discharge pipe. A great deal of care was necessary in supporting and bracing the discharge pipe to the tunnel timbers. The plant serving the pneumatic mixer was very similar at both ends of the tunnel. It consisted of a gravity feed gravel bin, filled directly from cars by a clamshell operated from a stiff leg derrick. The gravel fed from the hopper directly into a measuring bin, in which the cement was added and from which it fed directly into the top of the pneumatic mixer by gravity. The water was added at the time the mixer was being filled. Care was necessary at all times to watch the gravel carefully for large sized stones. Anything over four inches was very liable to plug the pipe. This trouble was mainly overcome at the source by the installation of screens at the gravel pit at Frenchtown, Mont.

The fact that the pneumatic mixer discharged at the roof on the center line of the tunnel necessitated setting up and filling both the side wall and arm forms at one operation. It was occasionally impossible, however, to complete the filling of a form at one operation on account of the speed with which the concrete was discharged, causing the form to spring at about the spring line. When the form showed signs of springing, work was discontinued and connections were made at another form until the concrete in the first form had set sufficiently to allow the continuation of filling to completion. There were six complete sets of forms in use, with a discharge pipe for each form, which was connected and disconnected from the main supply pipe on the floor of the tunnel, which extended the full length of the portion being lined. This, of course, saved a great deal of delay since when one form was completed it was only necessary to disconnect the discharge pipe and make connection at another form. The discharge pipes were supported from the roof of the tunnel and moved ahead with each form.

Operating Data for Pneumatic Mixer.—Considerable experimenting was done with this mixer. The speed attained varied according to the distance. On one form located 700 ft. from the mixer a batch was shot at intervals of 1 minute and 47 seconds for a total time of 3 hours and 20 minutes, this being at the rate of 13.45 cu. yd. per hour. On another form 13.22 cu. yd. was deposited per hour for 4 hours and 45 minutes, or at the rate of a batch every minute and 49 seconds. At longer distances the speed was greatly lowered, however, under the first method used whereby each batch was shot through to the form before another batch entered the pipe. At a distance of 1,000 ft. from the mixer, by this method of entirely clearing the pipe of the charge, it was necessary to hold the air on the mixer until the mixer dial dropped to 15 lb. This resulted in a large loss of air and took five or six minutes per batch, two minutes of which was required to blow the batch, thus reducing the air pressure to 65 lb. and three minutes to build up the air pressure to 105 lb. necessary for successful operation. By experimenting the method of not entirely clearing the pipe of one batch before another was started was used successfully, resulting in a shot every two minutes at a distance of 1,000 ft. Of this two minutes, 40 seconds was required in blowing the batch, the mixer air dial dropping to 35 lb. while the main pressure dropped to only 85 or 90 lb. It then required one minute and twenty seconds to build up the air pressure to 105 lb. again ready for another shot.

The results obtained with the pneumatic mixer were very satisfactory, both when located at the portals and on the car. The concrete was very dense and it was possible to obtain a much more dense and impervious roof than when placed by hand. The most essential feature is the plant. There must be an abundance of air and storage capacity. The traffic delays with the pneumatic car, which were the only delays experienced, were much more than the combined delays of the mixer at the portals, amounting to about 78 per cent in the former, as compared with about 60 per cent in the latter. Of this 60 per cent it will be noted that the greater part was on account of pipe delays.

The Forms. Wooden forms were used throughout. The length of the section was 20 ft. The side wall forms carried the concrete to about 4 ft. above the spring line. The forms were braced strongly at the base by struts across the tunnel and against stakes driven into the ballast. They were tied to the tunnel timbering by means of wires connecting with butterflies to bolts in the form. The forms were moved ahead by means of steel rollers placed on the floor of the gutter. About four hours was consumed by five men in taking down, moving and setting up a pair of wooden forms. When forms were to be moved for a considerable distance in the tunnel a form moving car was used. The car was easily and quickly operated. The record time for moving one pair of forms for a distance of 4,000 ft. from the time the form moving car was spotted at the form with the locomotive attached, until the form was secured at the new location and the work train engine and car had cleared the tunnel was 35 minutes. A total of 16 forms were in use, spaced at convenient distances throughout the section of the tunnel, which was being lined at one time, usually about 400 ft. apart. The walls were poured to the top of the side wall forms 4 ft. above the spring line in advance of the arch, which was placed and poured after the side wall concrete had set and the form moved, except where pneumatic mixer was used, where the side walls and arch were both poured at the same time. The arch sections were 20 ft. long, the same as the side wall sections. Generally 48 hours were allowed before the forms were broken loose but in cases of need this was reduced occasionally to 18 hours. No trouble was experienced with the concrete sticking to the forms. In all cases, the side wall forms were moved as a unit, independently of the arch. The arch form was not moved as a unit, but was collapsed and assembled at each set-up.

Grouting Tunnel.—The entire tunnel was grouted. The Ransome Canniffe grout mixer was used. Six of these machines were arranged in batteries of two to a car. The machines were installed on an ordinary flat car, one at each end, with material bins in the center. The sand was shipped from Beverly, Wash., and was sacked in cement sacks at the tunnel before being loaded into the car. The grouting was placed by compressed air at a pressure of 100 lb. per sq. in., received from the main line on the floor of the tunnel, tees being provided at proper intervals for connection to the mixer. Water was received in like manner from a water line which was carried the entire length of the tunnel. The air connections were made with 2-in. flexible air hose and 2-in. pipes with the lower end threaded for the group pipe connection were placed in the arch at intervals varying from 4 ft. to 20 ft., depending upon conditions. Some of these pipes were placed in the form before the concrete was poured, but they were apt to become plugged or dislodged during the concreting, and for the greater part of the tunnel these pipes were placed after the concrete had set. The holes were drilled by an air drill and the pipes driven to position. A flexible 2-in. air hose connected the grout machine with the grout pipe in the roof of the tunnel. At the beginning of grouting the mixture used was one-half sack of cement to one sack or 0.9 cubic feet of sand. This was later changed to one-third sack of cement to one sack of sand, equalling 30 batches per cubic yard. The total quantity of grout placed in the tunnel was 8,768 cu. yd., equalling 1.66 cu. yd. per lineal foot of tunnel exclusive of the rock section, in which it was only found necessary to place about 50 cu. yd. on account of the dryness and the density of the concrete, which was placed by the pneumatic method.

There was a very great difference in the amount of grout placed in the different holes. When operations commenced at a new location the grout ran each way from the hole, sometimes as far as 100 ft. The greatest number of batches shot in one hole before the refusal point was reached was 2,670, which equals 89 cu. yd. The usual quantity necessary to fill a hole to point of refusal, however, was between 15 and 20 cu. yd.

Below is a summary of the concrete yardage placed at different locations by the different machines for the entire job, amounting to a total of 39,244 cu. yd.

Power house foundations	88
Gravel bin foundations	1
Footings, timbered section	4,511
Footings, rock section	990
Struts, baffles and drain	96
Side walls	19,600
Arches	12,341
Rock section, columns	389
Rock section, girders	1,243
Total	39,271

The work was in charge of C. F. Loweth, chief engineer Chicago, Milwaukee & St. Paul Ry.; E. O. Reeder, assistant chief engineer; J. F. Pinson, assistant engineer from May 15, 1915, to June 20, 1916; C. F. Urbutt, assistant engineer from June 20, 1916, to completion on Feb. 1, 1917, and S. H. George, assistant engineer from May 15, 1915, to completion on Feb. 1, 1917.

Relation of Weight of Rail to Weight of Locomotive

In a paper read Dec. 14 before the Maintenance of Way Club of Chicago, J. S. Robinson, Division Engineer of the Chicago & Northwestern Ry., gave the following information regarding the weights of rail and the rolling loads:

We know that rolling loads passing over rails cause a wave motion under which the rails deteriorate, and the greater the weight the greater the damage to rail. Without considering the design of the rail nor the details of its manufacture, the weight should be proportioned on heavy grades and curves about as follows:

For road engines with 75,000 to 100,000 lb. on drivers 75 to 85-lb. rail.

For road engines with 100,000 to 150,000 lb. on drivers 85 to 95-lb. rail.

For road engines with 175,000 to 200,000 lb. on drivers, 95 to 100-lb. rail.

For road engines with over 200,000 lb. on drivers, 100-lb. rail.

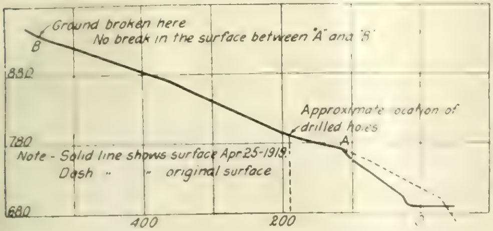
A freight engine with 200,000 lbs. on the drivers should require not less than 95 lbs. to the yd.; an engine with 250,000 to 300,000 lbs. or heavier on the drivers should require a rail of not less than 100 lb. to the yd. On easy grades, straight track or light curves this can be reduced 5 lb. per yd.; and this rule applies to high-speed passenger engines, although they may have less weight on the drivers. In yds. where the rail runs generally from that used on light lines, known as second-hand rail of 60 to 70 lb. section, and where the switch engines have neither trailers nor pony trucks, with engines of 175,000 to 200,000 lb. on the drivers, the lead tracks and turnouts in receiving and make up yds. should be laid with not smaller than 90-lb. rail and the interior tracks with not smaller than 80 lb. rail. In storage yds. light rail can be used.

We know that there are rails of from 60 to 70 lb. per yd. that are very tough and will carry very heavy loads in yds., but the increased number of ties and heavier ballast used, together with the increased cost of maintenance, make it economical to use heavier rail. Mr. Robinson considers that for switch engines of 90,000 lb. on the drivers, 70 to 75-lb. rail will be required for leads and turnouts, and 60 to 65-lb. rail for interior tracks. For switch engines from 100,000 to 150,000 lb. on the drivers, 80 to 85-lb. rail should be used on leads and turnouts and 70 to 75-lb. rail on interior tracks. For switch engines of 150,000 to 200,000 lb. on the drivers, there should be 90-lb. rail on leads and turnouts and 80-lb. rail in interior tracks.

Preventing Slides by Dynamiting Sub-Strata

During the building of the Kanawha & West Virginia Ry.'s new line from Gauley Bridge to Belva, W. V., between September, 1917, and June, 1919, a bad slip occurred at Belva, the handling and relief of which gave rise to very interesting problems. How these problems were solved is described by C. M. McVay in the December issue of the Railway Maintenance Engineer, from which the notes following are taken.

The slip extended a distance of 900 ft. along the new line. The maximum depth of cut on the center line at this point of the slide was about 30 ft. and the preliminary sections called for 22,559 cu. yd. of excavation. When construction work was completed, however, a total of 75,631 cu. yd. had been removed.


Ground broken here
No break in the surface between "A" and "B"
B
A
880
780
680
Approximate location of drilled holes
Note - Solid line shows surface Apr 25-1919.
Dash " " original surface
400
200

Average Section Through Hillside.

It was evident that the ordinary remedies for slides, such as piling, bulkheads or walls, would not hold or stop this movement, as it all came from above and would have covered such structures in a short time. The top of a hard layer of blue clay, soapy and impervious to water, extended six to ten feet above the new grade. The entire formation above the blue clay was a sandy yellow clay with about 30 per cent of boulders and loose rock. This formation was very porous and the water ran down through it to the blue clay formation and then along the top of this to the face of the cut. The top formation was loosened in this manner and in wet weather simply slipped over the blue clay.

In May, 1919, a break was discovered about 500 ft. up the side of the mountain and the entire section below it seemed to be moving towards the track. It was then determined to attempt a remedy by drilling through these upper formations to the solid rock and breaking up the various strata by explosives so that the water would pass through them rather than flow toward the face of the cut. A 4-in. "Cyclone" gasoline drill was installed and holes drilled about 75 ft. back of the top of the slope of cut and 75 ft. apart. A total of 11 holes were drilled, ranging from 95 ft. to about 130 ft. deep. These holes were from 110 to 190 ft. from the center line of the main track. They were drilled from 8 to 10 ft. into the soap-stone formation which surmounted the solid rock 20 to 25 ft. below grade. It was necessary to case the top part of each hole in the sandy clay and boulders. As soon as a hole was drilled it was sprung and immediately loaded and shot. About 100 lb. of dynamite was placed in the bottom or rock shot and about 75 lb. in the upper or blue clay shot, the latter being placed at about the height of the grade. Between the lower and upper shots the holes were filled with sand. The holes necessitated their shooting quickly after cleaning as water ran in very rapidly. In each case the casing was pulled after the hole was loaded and everything made ready for shooting.

There was no distortion of the face of the cut or the ground around the hole as a result of the shooting and the surface dried up immediately. Since the completion of these holes two years ago the cut has held up in good shape and has never blocked the track. As the front slope is now becoming well covered with vegetation no further trouble of a serious nature is anticipated. The total length of holes drilled was about 1,232 lin. ft. The total cost of drilling and shooting the holes was $1,816.92, which represents a cost of approximately $1.47 per lin. ft. of hole. The entire work of drilling and blasting was started late in May, 1919, and finished early in July.

Elements of an Engineer's Employment Contract

The considerations entering into an engineer's employment contract were outlined by John E. Hughes, general counsel, American Association of Engineers, in the November issue of the Professional Engineer, from which we are reprinting the matter that follows

A contract is an agreement to do or not to do a particular thing. The indispensable requisites of every valid contract are: offer, acceptance and consideration.

An offer is a promise to do or not to do something.

Acceptance is the acquiescence therein of the other contracting party.

Consideration necessary to the formation of contract, is either a benefit to the party promising or a loss or detriment to the party to whom the promise is made.

One promise is a good consideration for another promise and an act is a good consideration for a promise. Thus if A says to B "If you will work for me I will pay you $100 a week" and B replies "I will," a contract is made because B has given his promise for A's promise and that constitutes the consideration. If B says nothing but goes to work for A his act in so doing is a good consideration and the contract is formed.

The parties to a contract must be of legal age, otherwise the contract is voidable at the option of the infant but binding on the adult. If one of the parties is mentally incompetent or there is a mutual mistake of fact no contract can exist. A misrepresentation as to a material fact made by B to induce A to employ him, even though innocently made, allows A to void the contract if he believed it to be true and employed B relying thereon. Intentional misrepresentation is fraud and has the same effect. Duress and undue influence also render a contract voidable. An agreement by B to work for A in an illegal employment such as to sell stock in violation of law, to deal in intoxicants in violation of law, to use improper methods in obtaining a public contract or to improperly influence the action of a member of the legislature, a public officer or judge, or to do an immoral act, is contrary to public policy and unenforceable at law. The courts in such case will aid neither party regardless of what may have been done or expended under the illegal agreement. In certain cases an agreement to employ only union labor has been held contrary to public policy.

Written or Oral Contracts.—A contract of employment may be either written or oral, with equal validity, except that the statute of frauds in force in nearly all of the states provides that a contract not to be performed within the space of one year must be in writing. In construing this statute the courts have held that if an agreement does not by its express terms require more than a year for performance and may possibly be performed within a year it need not be in writing. Thus if B agrees to employ A until the building of Union Station is completed and the plans and specifications for Union Station require three years to complete, nevertheless the contract need not be in writing for it is not impossible to complete it within a year. But if B agrees to work for A for 14 months the contract must be in writing. In such a case if A refused to B for his work on the ground that the contract was not in writing B could not recover for it at the contract price because the contract is unenforceable, but he could recover the reasonable value of his services on the theory that A would be unjustly enriched if allowed to receive them gratuitously.

Termination of Contracts.—A question constantly arising in connection with employment contracts is regarding termination. Is notice necessary to terminate an employment contract? The answer is generally no. Unless the employer expressly agreed to give a definite notice when he hired the employe he may discharge him without notice, remaining liable for damages if a contract was breached thereby.

Damages.—When is an employer liable for damages for discharging an employe? Unless the contract of employment was for a definite period and the employe was discharged without cause the employer is not liable. This means the employer need not pay the employe anything except for the time actually worked. A false impression seems to prevail generally that legally an employe is entitled to a definite notice of dismissal or to pay up to the next pay day. The fact that A is paid by the month or by the year or by the week does not mean that he is employed for a like period and does not render the period of his employment definite.

The average case of hiring is perhaps similar to this: B applies to A for a position. A considers the application favorably and wires B "Come at once. [illegible] per month." B comes and goes to work. This constitutes a hiring at will and A may discharge B at any time or B may resign without liability on the part of either. If B had stated in his application "I hereby apply for a position for one year," and A had then wired him to come as above stated, it would have been a contract for a year because the words "for one year" in B's application would have definitely fixed the duration of the hiring. If A had then discharged him he would have had an action for damages unless he was discharged for good cause. The rule of law is that a hiring for an indefinite period is a hiring at will and may be terminated by either party at any time without notice or liability.

Cause for Discharge.—What is good cause for the discharge of an employe, the existence of which will excuse the employer from liability? If an employe is discharged before the expiration of the term of his employment, as definitely fixed by his employment contract, the employer must answer in damages unless he can prove to the satisfaction of the court or jury that the employe did not discharge his duties with the skill and diligence ordinarily used by employes of the same calling under the same circumstances, or that he did not show the ordinary respect for his superiors.

Damages for Wrongful Discharge.—What damages is an employe entitled to for wrongful discharge? An employe is bound to use due diligence to find other employment in his calling. If he does not succeed he is entitled to his salary as if he had not been discharged. If he procures other employment at a less salary than the employment wrongfully terminated, he is entitled to claim the difference as damages. The rule of law governing damages for breach of contract is that one is entitled to the value of his contract. He is, however, bound to do everything he reasonably can to make his damages as small as possible. This does not mean that an employe is bound to accept employment at work other than his trade or profession.

It is possible that in a few states of the Union the legislature has enacted a statute prescribing a definite notice to terminate employment but in the great majority of states such a statute does not exist.

Where there are disputed questions of fact in connection with a wage suit the employe has the right to have them determined by a jury. The experience of attorneys who have tried this class of cases is that juries are inclined to favor the wage claimant.

Research Graduate Assistantships in U. of I. Engineering Experiment Station.—It is expected that 11 research graduate assistantships in the Engineering Experiment Station of the University of Illinois will be filled this spring. These assistantships are maintained for the purpose of assisting in the conduct of engineering research and to extend and strengthen the field of its graduate work in engineering. These assistantships, for each of which there is an annual stipend of $600 and freedom from all fees except the matriculation and diploma fees, are open to graduates of approved American and foreign universities and technical schools who are prepared to undertake graduate study in engineering, physics, or applied chemistry. Nomination to these positions, accompanied by assignments to special departments of the Engineering Experiment Station, are made from applications received by the director of the station each year not later than the first day of March. Nominations are based upon the character, scholastic attainments and promise of success in the principal line of study or research to which the candidate proposes to devote himself. Preference is given those applicants who have had some practical engineering experience following the completion of their undergraduate work. Appointments are made in the spring and they become effective on the first day of the following September. Further information may be obtained from C. R. Richards, Director, Engineering Experiment Station, Urbana, Ill.

Commercial Operation of Airplanes

Data on the operation of airplanes as vehicles of transportation for profit that should be useful in an investigation and analysis of this service were given by L. B. Lent, Chief, Engineering and Survey Division, Aerial Transport Corps, in a paper presented at the annual meeting of the American Society of Mechanical Engineers, December, 1921. Mr. Lent's paper, an abstract of which is given below, is based on the operations of the air mail service of the U. S. Post Office Department for the year ending Sept. 30, 1921.

There has been in operation in the United States since May 15, 1918, what may be properly characterized as the largest commercial operation of airplanes in the world; namely, the Air Mail Service operated by the Post Office Department of the United States Government.

This service is operated by a purely civilian personnel and is very similar in nearly all respects to that which would be effective in a purely commercial service. Moreover, the records of this service have been carefully kept during its entire existence, and if properly interpreted can be used as a basis for estimating the probable performance and costs of any commercial service of the immediate future.

Organization.—The Transcontinental Air Mail Service operates daily in each direction between New York and San Francisco, an air line distance of 2,630 miles and a total daily mileage of 5,260 miles.

Equipment.—The airplane equipment now used in this service has been standardized and all machines are the De Haviland planes equipped with Liberty 12 engines turned over to the Mail Service by the War and Navy Departments. These machines are rebuilt to accommodate the mail load in the cockpit in front of the pilot and strengthened to meet the hard service required.

The total investment of the Air Mail Service is about

TABLE I—SUMMARY OF OPERATING RECORDS OF U. S. AIR MAIL SERVICE, OCT., 1920-SEPT., 1921

Trips possible (scheduled)	9,482
Trips attempted	8,520
Trips defaulted	962
Trips uncompleted	549
Trips in fog	3,013
Trips in clear weather	5,247
Mileage possible	1,921,784
Miles traveled	1,697,560
Per cent of performance	*88.33
Mail carried, lb.	1,1[illegible],518
Forced landings due to mechanical troubles	778
Forced landings due to other causes	966

*For last 6 months, 98 per cent.

TABLE II—CONSOLIDATED COSTS OF OPERATING U. S. AIR SERVICE FOR YEAR ENDING OCT. 1, 1921

		Per cent of total.
Gasoline	$ 221,546	15.0
Grease and oil	49,567	3.35
Repairs and accessories	275,962	18.6
Miscellaneous	170,469	11.5
Motor cycles and trucks	63,816	4.3
Rent, light, fuel, power, telephone and water.	28,310	1.91
Office force and watchmen	128,849	8.7
Warehouse	29,[illegible]34	2.0
Pilots	191,097	12.8
Mechanics and helpers	215,[illegible]75	14.5
Radio	[illegible]	1.04
Departmental overhead charges	[illegible]	[illegible]
Total	$1,482,[illegible]21	

TABLE III—ANALYSIS AND CONSOLIDATION OF FIGURES FOR PERIOD OCT. 1, 1920-SEPT. 30, 1921

	Service and unit cost					Cost per mile, cents		
	Gasoline, gal. (1)	Total time, hr.-min. (2)	Total miles (3)	Cost per hour (4)	Cost per mile (5)	Overhead (6)	Flying (7)	Maintenance (8)
1920.								
Oct.	60,010	1,852-56	[illegible]	$66.71	$0.80	$0.18	$0.23	$0.39
Nov.	[illegible]	1,651-20	[illegible]	[illegible]	0.87	0.21	0.27	0.39
Dec.	[illegible]	[illegible]	[illegible]	[illegible]	1.00	[illegible]	0.29	0.18
1921								
Jan.	51,127	1,668-51	[illegible]	81.78	0.98	[illegible]	0.27	0.48
Feb.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.25	0.27	0.40
Mar.	[illegible]	[illegible]	[illegible]	[illegible]	0.82	0.19	[illegible]	0.38
April	[illegible]	[illegible]	[illegible]	[illegible]	0.79	0.18	0.25	0.36
May	[illegible]	[illegible]	[illegible]	[illegible]	0.69	0.19	0.24	0.26
June	[illegible]	[illegible]	[illegible]	[illegible]	0.69	0.15	0.23	0.31
July	[illegible]	[illegible]	[illegible]	[illegible]	0.73	0.18	0.22	[illegible]
Aug.	[illegible]	[illegible]	[illegible]	[illegible]	0.71	0.16	0.22	[illegible]
Sept.	[illegible]	1,667-06	[illegible]	[illegible]	0.70	0.17	0.21	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]	$0.808			

Averages for year [illegible] $0.246 $0.368

Total average for year, 80.8 cts. per mile

Average for last 6 months [illegible] $0.182

Total average for last 6 months..71.83 cts. per mile

Average speed for the year [illegible] miles per hour

Average speed for the last 6 months [illegible] miles per hour

$800,000, of which $133,000 is for buildings, trucks, tools, etc., the remainder being for airplanes and [illegible]

It is obvious that the actual number of planes in serviceable condition and under repair may vary from day to day, but the following is a fair average figure for the year. In serviceable condition, 50; under repair, 18; awaiting repair, 20. During the year, 27 planes were damaged beyond repair and salvaged, while 48 new planes were placed in service and about 20 experimental types retired.

Engine equipment has always been in excess of actual need, because of the large number of Liberty engines turned over by the Army. The total number of Liberty 12A (Army high-compression) and Liberty 12N (Navy low-compression), developing about 400 and 350 hp., respectively, in use is about [illegible]. Engines in serviceable condition in planes and as spares, 150; engines under and awaiting repair, 350. The foregoing figures do not represent the engine requirements for such a service.

An accurate estimate of the total engine requirements for this service can be based on the following: 22 engines are required for the 22 planes in daily service; at least 1 spare engine should be at each major station, making a total of 14; another supply of approximately 30 engines is necessary for those constantly in transit between the various fields and the overhaul stations, including the period of overhaul, making a total of 66 engines. If this service is properly organized a total of 75 engines is ample for successful operation of such a service.

Operating Record.—The operating record for the past year is shown in Table I. For a thorough understanding of these figures it is thought well to briefly outline the conditions under which the service was rendered.

The transcontinental course is divided into 13 legs of approximately 200 miles each with stations as given above. The route is divided into three major divisions—the eastern, extending from New York to Chicago, the central from Chicago to Rock Springs, Wyo., and the western, from Rock Springs to San Francisco, Cal. It has been found that in the western trip the flight is hampered by prevailing westerly head winds, whereas the eastern trip is, of course, assisted by such conditions. Inasmuch as the supply of gas for each ship is approximately only four hours at cruising speed, it becomes necessary in many flights to stop at intermediate stations for service. Many times coming east, planes fly a major leg of approximately 400 miles. The number of such trips per month is somewhat varied, depending upon conditions.

While the available space in each plane accommodates 400 lb. of mail, the average amount carried per trip for the entire year was less than 150 lb. per plane per trip. These planes carry a pilot only, who flies a leg in one direction each day, returning to his home station the next day and laying off the third day. This schedule is, of course, subject to change, which occasionally results in a pilot doing more mileage than indicated.

The total flying time per day varies with the weather conditions, but the average speed for the entire year was 86.3 miles per hour; for the last 6 months (during better weather conditions) the average speed was 87.88 miles per hour. Up to the present time all flights have been made during the day. An indication of what is possible in a continuous trip, is the record established on Feb. 22 and 23, when the mail was carried from San Francisco to New York in elapsed time of 33 hours 20 minutes, or a total flying time of 26 hours 50 minutes. The fastest scheduled train time between these two points is 92 hours. The eastbound trip from Chicago to New York has been made in 5 hours 30 minutes. The flight from Salt Lake City to San Francisco was made on Oct. 14, 1921, in 6 hours 1 minute elapsed time, or a total flying time of 5 hours 32 minutes over a distance of 624 miles. The fastest train between these two points is scheduled for 24 hours 15 minutes. It follows that, for the transcontinental distance, daylight flying only will cut train time about in half, and with night flying, the time is cut to about one-third.

The operation record discloses one feature of special merit given under "Per Cent of Performance." It will be noted that the percentage of performance for the year was 88.33 per cent. For the last 6 months this average was 98 per cent, of which 96 per cent was actually completed on scheduled time. In view of the fact that the Pennsylvania R. R. in its printed timetables boasts of a train performance of 95.6 per cent on time, the foregoing record for the last 6 months is truly remarkable.

During the year ten pilots and one mechanic were killed, four of the former during the last six months. This is equivalent to one pilot killed for each 169,756 miles flown.

During the year 27 planes were so badly wrecked that they were salvaged instead of repaired, and there were 145 forced landings which resulted in damage to planes necessitating repair work; of these about 100 required major repairs. Obviously some were damaged more than once during the year. Of the total number of forced landings only 172 resulted in damage to the planes. This is one plane damaged for every 10 forced landings.

It should, in fairness, be pointed out that all landings other than those regularly scheduled, even though made on an intermediate Air Mail field, are counted as forced landings.

Cost of Operation.—The consolidated costs of operating this service for the yearly period chosen are shown in Table II. It will be noted that there is no charge for interest on investment. This is of course a proper charge in any commercial service and should be added in any estimated costs. By making such a charge and adding it to the total costs shown in the table, it is thought that the figures resulting are safe and conservative for estimating the operating costs for any similar commercial line. In fact, the figures shown can be very much bettered if advantage is taken of the experience gained in the Mail Service.

An analysis and consolidation of the figures are shown in Table III which give the service and unit costs and the costs per mile for the year. In this table the total costs are divided into three general headings, namely, Overhead, Flying and Maintenance. Under the head of Overhead is included departmental overhead, office force and watchmen, motorcycles and trucks, rent, light, fuel, power, telephone, water and radio. Maintenance consists of miscellaneous, mechanics, helpers, repairs and accessories, and warehouse charges. Flying consists of gasoline, grease and oil, and pilots.

It will be noted that the mileages as shown in Table I and in Table III do not agree. The former figure is miles traveled in regular mail trips and the latter is "total miles" flown, which includes ferry trips, test flights and retrieving planes. The "total miles" is the proper basis for estimating costs per mile.

An examination of Table II will show that the largest items of cost are gasoline (15.0 per cent of the total), repairs and accessories (18.6 per cent), pilots (12.8 per cent) and mechanics and helpers (14.5 per cent). Considering these separately, it is seen that the gasoline cost cannot be materially reduced by the use of more economical engines, for even if engine economy is increased, say 10 per cent (which is difficult), the total reduction would only be one-tenth of 15 per cent, or 1.5 per cent of the total.

The largest item, repairs and accessories, is susceptible of considerable reduction. The elimination of forced landings and the damage resulting therefrom would largely reduce this charge. Fair wear and tear on places is relatively very small.

The basis on which pilots are paid, namely, $2,000 per annum, plus 5, 6 and 7 ct. per mile flown, has proved to be very satisfactory, and more so than any other basis tried by the Mail Service. In all cases it supplies the men with by increased pay.

The pay for chief mechanics in the Mail Service averages $2,000 per annum; other mechanics from $1,400 to $1,800 per annum; helpers from $1,100 to $1,400 per annum; and watchmen and helpers from $900 to $1,200 per annum.

An explanation of the item rent in Table II is essential. In most of the major fields the Mail Service was supplied with flying field, and in some cases with hangar facilities, by the cities in which they are located, without charge therefor. Rent for field and hangar facilities is paid at New York, Bellefonte, Pa., Cleveland, Ohio, Bryan, Ohio, Chicago, Ill., and College Park, Md. (training station). At all other cities west of Chicago no rent is paid.

This item of cost is therefore comparatively low and should be modified if used for estimating similar costs of a commercial line, unless similar arrangements could be made with various municipalities for use of municipal airdromes. If commercial companies have to purchase flying fields, as well as field equipment, it would, of course, add largely to the capital costs, as well as the operating charges. It is believed, however, that very favorable arrangements can be made with most of the large cities in the United States for proper landing field facilities.

The analysis of Table III shows that the average yearly operating cost per flying mile was [illegible] ct. and for the last six months of the year, 71.82 ct.

As mentioned before, if the cost is reduced to a ton-mile basis, the figures resulting will be unreliable. A fair basis of comparison is on a plane-mile basis, for it costs but little more to fly a plane loaded to its capacity than it does to fly it empty. It is a safe statement that under the conditions prevailing in the Mail Service the cost per plane-mile will soon be reduced to the neighborhood of 60 ct.

With proper equipment and organization, a commercial service using single-engine planes of not over 400 hp. each and flying only one round trip per day over a distance equivalent to that of the transcontinental service can be accomplished for a total cost not exceeding 70 ct. per flying mile. This is especially true if more than one round trip per day is flown.

Life and Maintenance of Planes. It may be noticed that in the foregoing no account is made of depreciation. In the present service no plane has remained intact long enough to wear out and so determine even approximately a rate of depreciation. Before a plane wears out most or all of the parts are replaced and charged up under that heading, or else it is so completely destroyed as to be retired from service, charged off entirely, with credit for such material as can be salvaged for use in repairing other planes. A fairly accurate idea of the rate of this destruction may be had from the following data.

During the year 27 planes were so badly damaged that repairs were not undertaken, these planes being salvaged. Of the many forced landings, 145 resulted in "crashes" necessitating repairs, of which about 100 necessitated major repair work. The number of "crashes" is thus about 10 per cent of the total number **of forced landings. The average for the** year is one "crash" for each 17,560 miles flown with mail; and for the last six months, 31,211 miles.

The number of planes required as original equipment to operate such a service as the Mail Service and the rate and cost of replacement may be estimated as follows:

1 plane for each of the 22 daily flights	22
1 spare plane for each daily flight, to be used in case of [illegible] trouble with scheduled plane	22
1 spare plane at each of the 14 fields which may be in transit to and from repair shops and under repair	14
Total	58

Mail-Service experience shows that after a plane has had about 450 hours in the air it is necessary to lay it up for a **thorough inspection and reconditioning. This operation in**volves some labor and material (usually new wing covers, etc.) and costs an average **of $600 per plane. The total time required for such an operation at present is about two months.** Since **the flying hours per year are 21,952, the total number** of such overhauls is 21,952 ÷ 450 or 49. The record also shows that about 100 planes were so damaged as to require repairs. The average cost of these repairs was about $1,000 each and the average time about two months per plane. The present rate of repair and overhaul for the entire Mail Service is about 11 to 12 planes per month.

It is thus seen that about 14 to 15 planes (about one for each 14 [illegible]) must be constantly traveling to and from the repair shops and undergoing repairs. It should be stated that some minor re**pairs are made at many fields as well as at** the main repair shop in Chicago.

An analysis of the above shows that:

a. The original plane equipment is about one [illegible] for each [illegible] miles of scheduled flight.
b. [illegible]
c. [illegible] miles flown.
d. [illegible] for each [illegible] miles flown.
e. [illegible] per mile.
f. [illegible] per mile.
g. [illegible] for 27 [illegible] per mile.
h. [illegible] per mile.

This amounts to a total estimated cost of $[illegible],000. **Deduct**ing this amount from the total $[illegible] (Table III) leaves $[illegible], which is credited to engines as the cost of engine overhaul and renewals, or about [illegible] ct. per mile.

Life and Maintenance of Engines. The record of engines actually overhauled, repaired, salvaged, etc., is so involved in the available data that it is difficult to compute the exact data. However, [illegible] overhaul [illegible] that it is more accurate to base an estimate on the present rate than to use total figures for the year.

Present methods of conditioning and caring for engines have resulted in an almost uniform service of 100 hours of running between each overhaul unless an engine is damaged in some "crash." Since a total daily mileage with mail is about 5,300 miles and the average speed is 86.3 miles per hour, the daily flying time is about 62 hours per day. To this must be added the time consumed in warming up engines (6 hours) and the time of engines on various test stands, so that the total daily time for the service is 80 engine-hours. This is equivalent to 0.8 engine replaced per day. Crashes, mechanical troubles and causes other than plain wear bring up the rate to just about 1.0 engine per flying day. While **this may seem high, considering that only 22 planes fly reg**ularly each day, it is not, for 100 flying hours per engine between overhauls is a very high figure and can only be attained by the most efficient and systematic conditioning **and repair methods in force in the Mail Service. While about 300 engines were used, the whole 300 were not actually over**hauled, as many new engines were placed in service during **this period. The yearly demand is, however, at about a rate of 300 engines per** year.

This running time of 100 hours between overhauls is true **even after the second and sometimes the third overhaul, the necessary replacements being made at each overhaul.**

The average time of an engine overhaul is as follows:

	Hours
One mechanic and one helper, 10 days, 8 hours each	80
Washing and valve grinding by other men	8
Carburetor work, cleaning and adjusting	4
Ignition work	4
Block testing	6
Total	102

This total time may vary 50 per cent each way, but it is a fair average. The average labor cost is about $75 per engine. The average cost of the necessary material replacements, based on Government war prices, is $150. The average total cost is therefore $225 per engine. This cost may seem excessive, but is justified by the amount of careful and accurate **work done, which is the real reason for 100 hours of further** statutory service.

Conclusions. While both the design and operating methods **are susceptible of improvement, it is believed that the fol**lowing are warranted from our present knowledge and **experience**

a. The number of planes required for a given service is about one for each 100 miles of scheduled flight.

b. The number of spare engines required is about 50 per **cent of the total number of planes.**

c. The total operating cost should not exceed 70 ct. per plane-mile for single-engine planes of not over 400 hp.

d. Scheduled flights over reasonably long distances can be at least twice as fast as the fastest scheduled trains, flying in daylight only, and at least three times as fast if night **flying is done.**

e. Night flying can be successfully accomplished with reliable power plants and a proper equipment of airdrome beacons and landing flares.

f. The most important and desirable improvement in present practice is the use of efficient commercial planes equipped with a thoroughly reliable power plant.

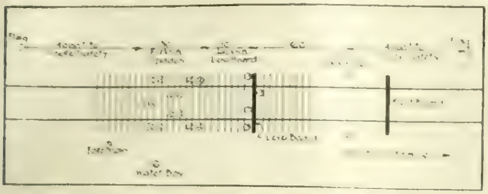
g. The United States is admirably adapted to commercial airplane service because (1) the large area permits long flying distances, (2) large centers of population well dis**tributed over this area should supply ample business, and,** (3) fast transportation of both goods and passengers is more in demand than in any other country in the world.

h. The development of a large commercial service will furnish a reserve of planes, pilots, mechanics and other highly **skilled men which would undoubtedly be the most valuable** and effective part of our national defense.

Gas Masks for Train Crews The U. S. Bureau of Mines has completed an investigation of gas masks for use of train crews in railroad tunnels. Results of the tests will soon be published by the Bureau in a technical paper entitled "Tests of gas masks and respirators for protection from locomotive smoke in railroad tunnels with analyses of tunnel atmospheres," by A. C. Fieldner, S. H. Katz, and S. P. Kinney. A small mask was devised that fits conveniently into a coat pocket, and in actual service with locomotive engineers and firemen was found to last two to six months before distasteful gas penetrated.

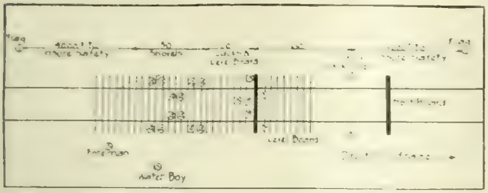
Organization and Distribution of Small Ballast Raising Gang

The accompanying diagrams reproduced from the September bulletin of the American Railway Engineering Association are based on time studies of raising track on ballast made by the Baltimore & Ohio R.R. They were prepared by a subcommittee of the Committee on Ballast and formed a portion of that committee's report. The committee recommended that the diagrams be approved as recommended practice and printed in the Manual of the Association. The time studies covered raising track on stone ballast and on gravel or cinder ballast. The schedule in both cases was for a final raise of 4 to 6 in. when completely renewing ballast. The operations and time distribution were as follows:



Ballast Raising Gang for Stone Ballast.

Distribution of Gang: (1) 2 flagmen, (2) 2 men digging jack holes and handling spot board, (3) 4 men handling jacks and level board, (4) 14 tampers, using forks inside and outside of rail working in pairs, (5) 1 foreman, (6) water boy



Ballast Raising Gang for Gravel or Cinder.

Distribution of Gang: (1) 2 flagmen; (2) 2 men digging jack holes and handling spot board, (3) 6 men handling jacks and level board, (4) 12 tampers, using shovels inside and outside of rail, working in pairs, (5) 1 foreman, (6) 1 water boy

STONE BALLAST

Operation No.	Operation.	Time distribution minutes per foot of one track stone
1	Running spot board	0.07
2	Digging jack holes	[illegible]
3	Jacking up track	[illegible]
4	Running level board	[illegible]
5	Tamping	[illegible]
	Water boy	[illegible]
	Two flagmen	[illegible]
	Foreman (assume gang of twenty men)	0.30
	Total minutes for one foot of one track	[illegible]
	Standard schedule, hours per foot of one track	.119

Progress [illegible] ft. per hour allowing [illegible] per cent detention account of trains.

GRAVEL OR CINDER BALLAST.

Time Study on B. & O. R. R.—Schedule for final raise of 4 to 6 in. when completely renewing ballast where track is tamped with shovels in gravel or cinder.

Operation No.	Operation	Time distribution minutes per foot of one track gravel or cinder.
1	Running spot board	0.07
2	Digging jack holes	0.35
3	Jacking up track	0.80
4	Running level board	[illegible]
5	Tamping	[illegible]
	Water boy	[illegible]
	Two flagmen	0.50
	Foreman (assume gang of twenty men)	0.25
	Total minutes for one foot of one track	5.18
	Standard schedule, hours per foot of one track	.086

Progress 257 ft. per hour allowing [illegible] per cent detention account of trains

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North Dakota Engineers Meet at Bismarck.—The third annual meeting of the North Dakota Chapter of the American Association of Engineers will be held in Bismarck, N. Dak., Feb. 9th and 10th.

The Relation of the Engineer to the Community*

By EVERETT J. LAKE.

Governor of Connecticut

As governor, the elected head of a state government, there are two angles of this question to which for a few minutes, I might call your attention. One is the practical side, simply a list of those positions in our state government which must be filled by competent engineers. Upon this I shall only dwell for a moment.

I do wish to say, however, that the State of Connecticut is proud of its Highway Department, and that this department is purely an engineering proposition. The splendid development of the road system in Connecticut is due to the work's having been done by engineers without the help of the politicians.

Our Rivers, Harbors and Bridges Commission, appointed primarily to build the million-dollar dock at New London, had and has largely engineering problems for its consideration.

Among the duties of the Shell Fish Commission are the locating and bounding of the oyster-bed leases by the state, and the engineer is a leading personality in their work.

The law itself requires that three of the six members of our Pollution of Streams Commission shall be engineers.

In our Department of Health the work of the engineer is as much needed and as quickly required in the case of health dangers as is that of the physician.

It is in the Engineering Department of the Public Utilities Commission that their most numerous personnel appears.

But I will not continue a catalog of those public offices in which trained engineers must of necessity serve. I will, however, speak of what I shall call the academic angle of my subject.

There are certain fundamental characteristics of a successful engineer, characteristics which he does and must apply to his profession if he be worthy of bearing the name of engineer, and I wish to urge upon you your duties as citizens to apply them in your consideration of the problems of good government and the public weal.

Today we often hear the expression, "Government needs the business man in public office," and if this be true, the need is emphatically for the engineering qualities of the business man.

The first qualification of an engineer is concentration. He must focus on his problem like a burning glass, and not study with the eye and mind of an impressionistic artist.

The next qualification is the power of analysis. The real analytical engineer does not tear apart with ruthless hands and throw into the scrap heap all that comes between him and the point of his ultimate investigation. He rather lays aside in an orderly and tabulated array the covering or by-products, if you will, that they may be again replaced if necessary, or perhaps put to other profitable use.

The third qualification of an engineer is his power of continued application. He learns to work continuously and laboriously.

And a fourth characteristic of the engineer is the quality of thoroughness. He must in his task, in his problem, bring it to completion. A half finished job is in his domain practically nothing done at all.

These, then, are the fundamentals of a successful engineer, and if he but avoids the one danger of his profession—that of allowing his concentration to restrict his vision, so that in the intense application to any one problem he does not see its full scope or misses an opportunity waiting at his very elbow—he becomes an ideal citizen and one of the great assets of a nation.

You engineers apply these qualities to your life work; I am asking you tonight that you give a little of them to your duties as citizens.

I read recently Fiske's opening chapter of the Beginnings of New England, wherein he describes the growth and transitions of governments.

First the oriental or ancient governments, where a conquering monarch by warfares and struggles conquered and enslaved; then through the Roman Empire and the Holy

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*Address Nov. 3 at a banquet of The American Association of Mechanical Engineers, Hartford, Conn.

Roman Empire, when powerful rulers and commonwealths extended by conquest but granted citizenship.

Through all of these years, these centuries, we find the people of the world receiving their rights, their liberties, as grants from rulers, expanded or contracted at the will of each individual monarch, or his appointed or self-appointed minister.

Then came those long years of struggle in northern Europe when men were learning self-government and applying that knowledge. One of the hardest lessons to learn was that of delegating governmental functions and yet holding their public officials from transferring their delegated power into personal authority.

With the birth of the United States at our Revolutionary War, the rule of the people was forever established. Forward has been our march both in knowledge of how to govern and our ability to apply that knowledge. So today we who are holding office are but your delegates to turn your desires, your determinations, into laws and enforcements. So I say it is the duty of all engineers to give a little of their ability, which has made them successful, a little of their time, perhaps an hour every day, to the duties of citizenship.

There are many engineers with all the qualifications of ideal public officials who, when asked to serve, say, "I haven't the time to do it"; what they really mean is that they have not given the time to prepare themselves to do it.

No matter how successful you are in your own business, you cannot be true and square and fair to the state if you cannot or will not take time to study its problems and know what its public officials are doing. With the same technical skill which the engineer, the inventor, the surveyor, the mechanic, puts into his own profession, it is the duty every day to study public life and public affairs so that if the time comes when he is needed by the state he will be prepared for this work.

With the same concentration, the same analysis, the same determination, the same thoroughness that you study and solve the problems of a big machine, a railroad, a river, or an excavation, study and solve the problems of government, municipal and state, and you will provide better than any other class of men a solid, firm foundation for good government. And then with all of our citizenship, see that there is erected upon this foundation a structure of government clean and pure to look at, strong and firm to hold.

The First Year's Work of the Federated American Engineering Societies

The American Engineering Council of the Federated American Engineering Societies held its first annual meeting at the Cosmos Club, Washington, Jan. 5 and 6, Dean Mortimer E. Cooley of the University of Michigan, president of the Council, presiding. Officers were chosen, the work of the past year reviewed and discussed, action taken on important matters of public and technical service, new financial arrangement put into effect, committees named, new policies sanctioned and old ones reshaped, and a broad and definite program outlined for the next twelve months. A leading event of the meeting was a dinner in honor of Herbert Hoover, who entertained the members of the Council and their guests at the University Club.

The Council engaged in a long discussion of the question: "Shall the American Engineering Council approve or disapprove of the principle of licensing or registering engineers?" The Council finally decided to direct the appointment of a committee which shall make a thorough study of the licensing question, including conditions nationally, and report thereon. This committee is expected to report at the next meeting of the Executive Board.

Reports of officers were approved. Dean Cooley in opening the meeting expressed his confidence in the future of the Council and outlined generally his plans for more effective organization to be carried out in cooperation with the executive secretary, L. W. Wallace. President Cooley will soon start on a tour of the South and Southwest. Mr. Wallace has also mapped out a travelling schedule to further the work of organization.

Encouraging reports over the outlook for accessions to membership were reported to the Council. The Engineers Club of Columbus, O., was admitted to membership. "It is gratifying to note," said the report of the executive secretary, "that with one possible exception, no society will withdraw at the moment from the Federation. There are more than twenty active prospective members." Mr. Wallace urged an active and aggressive campaign to secure a much larger membership, stating "that it is evident that the Federation cannot reach the maximum possible attainment until virtually every engineering society is a member."

The secretary's report showed that on Jan. 1, 1921, the membership of the society was composed of six national and fourteen state and local societies, a total of 20. On Dec. 31, 1921, there were eight national and twenty state and local societies, a gain of eight member societies representing 1414 member engineers.

Conditions in the mining industry, as stated by Edwin T. Ludlow, president of the American Institute of Mining and Metallurgical Engineers, and Major Arthur S. Dwight were responsible for a reduced contribution by the Institute to the Council for the coming year. As a consequence, the assessments levied upon the other member societies were cut down proportionately. This was accomplished by constitutional amendment. Both Mr. Ludlow and Major Dwight assured the Council that the Institute was warmly in sympathy with the Federation, with which it was anxious to go forward. Sharp reductions in the budget were thus made necessary, and, though the Council begins the year with a scarcity of funds, assurances have been given of additional financial aid in the near future.

"The financial situation is not such as to cause alarm," said Secretary Wallace in his report. "Careful management and the results to be expected from an active campaign for new members should enable the Federation to perform its work for 1922 without a deficit."

The balloting for officers resulted in the re-election as vice-presidents of Dexter S. Kimball, dean of the College of Engineering, Cornell University, and J. Parke Channing of New York. W. W. Varney of New York was again chosen treasurer. L. W. Wallace was re-elected executive secretary by unanimous action of the Executive Board.

The Council made provision for a continuance of its national publicity work under the direction of James T. Grady, Director of the Department of Public Information of Columbia University, New York. The results of the publicity work during the year were described by the secretary and by L. P. Alford, chairman of the Publicity Committee, as most gratifying.

"It is our conception," said Secretary Wallace, "that there is no more important work for the Federation to do than to inform engineers and the public as to the valuable work that the engineer is doing and to indicate to all concerned how essential he is to modern civilization."

The Council adopted an amendment to the by-laws providing that "the Executive Board shall hold a meeting at the close of the annual meeting of the Council, at which time it shall organize and fix and announce a schedule of regular meetings for the ensuing year." The Executive Board under this authority voted to hold five meetings, two in connection with the meeting of the Council.

The Council voted to continue support of the legislation for the relief of the United States Patent Office as embodied in the Lampert bill.

The Committee on Engineering Education, the Executive Secretary reported, preferred not to make any report at this time. "The subject of engineering education," he stated to the Council, "is being discussed at the present time by many competent agencies and the committee prefers to make a study of these activities and seek to coordinate their conclusions from the standpoint of the profession at large rather than attempt to start a new discussion. If the Council is to enter this field of discussion at all, it must make some distinctive contributions and it is not entirely simple to pick the right path."

The Council voted to cooperate in the movement to prepare for cyclical industrial depressions and unemployment by resort to public works projects. On this subject the Council received a proposal from Mr. Hoover, and it was decided to open conference with him to ascertain in what way the Council could best provide effective aid.

Topographic mapping and the establishment of a department of public works were other legislative matters in which the Council decided to continue its support.

Considerable discussion was provoked by the plan to establish a Federation journal which would be sent to every engineer enrolled in the Federation. The Publicity Committee made no recommendations and the Council took no definite action. It was generally agreed that some such contact should be established between the Federation and its enrolled membership, but there was diversity of opinion as to its form.

Track Extension and Reconstruction by Electric Railways in 1921

Track extensions built by electric railways in 1921 continue at the low level that has existed since 1916, according to statistics compiled by the Electric Railway Journal. The mileage reported for urban and interurban track extensions during 1921 for the United States and Canada is 147.10. This is divided 108.15 miles for city lines and 38.95 miles for interurban lines. Practically all this is made up of spurs and short extensions and few additions of any considerable extent were carried out due to the extremely difficult conditions under which railways were working. The city of Detroit stands out as the only place where new construction was undertaken in any great amount. There 46.09 miles of new track were completed.

Electrification of steam lines was also at a standstill during the past year. The extensions reported amount to but 8.08 miles, which is nearly the same as for 1920.

While track extensions have not been made, track forces have not been idle, as is indicated by the large amount of reconstruction carried out. The number of railways reporting reconstruction of their tracks the past year is 184 and they report a total 615.21 miles as reconstructed. This is greater than any year since 1917, the largest amount previously reported being for the year 1919, when 390.64 miles was reconstructed.

The accompanying tables, reprinted from the Electric Railway Journal, give a summary of the track construction in 1921 and a comparison of track construction by years.

SUMMARY OF TRACK CONSTRUCTION 1921

	New England District.	North of the Ohio and east of the Mississippi.	South of the Ohio and east of the Mississippi.	West of the Mississippi.	Total United States.	Canada.	Total.
Track Extension.							
Number of companies ...	4	26	16	[illegible]	71	7	78
Miles of track:							
Urban	1.55	65.15	9.43	25.62	101.75	6.40	108.15
Interurban	5.01	6.22	13.07	14.18	38.48	0.47	38.95
Total track extended .	6.56	71.37	22.50	39.80	140.23	6.87	147.10
Track Reconstruction.							
Number of companies ...	20	91	28	37	176	8	184
Miles of track:							
Urban	63.42	230.31	55.12	115.82	464.67	24.29	488.96
Interurban	21.84	65.18	8.00	30.03	125.05	1.20	126.25
Total track rebuilt	85.26	295.49	63.12	145.85	589.72	25.49	615.21

COMPARISON OF TRACK CONSTRUCTION

	Extensions					
Year	No. of companies	Urban track.	Interurban track	Electrified steam lines	Total.	Track rebuilt
1907	(*)	(*)	(*)		[illegible]	(*)
1908	157	1,174.5		34.00	[illegible]	(*)
1909	[illegible]	774.[illegible]		112.40	[illegible]	(*)
1910	217	1,204.8		192.50	[illegible]	(*)
1911	[illegible]	1,305.0		86.70	[illegible]	(*)
1912	171	869.4		80.80	[illegible]	(*)
1913	181	974.9		119.0[illegible]	[illegible]	(*)
1914	163	716.5		229.00	[illegible]	(*)
1915	[illegible]	596.0		148.20	[illegible]	(*)
1916	163	115.40	240.90	[illegible]	[illegible]	(*)
1917	121	251.10	125.60	[illegible]	[illegible]	375.40
1918	80	216.41	97.41	275.70	[illegible]	155.49
1919	73	110.90	29.67	287.60	428.17	390.64
1920	87	145.69	30.87	8.12	[illegible]	391.77
1921	78	108.15	38.95	8.08	155.18	615.21

*Not available.

ELECTRIFIED STEAM LINES 1921

	Extensions miles
New York, New Haven & Hartford R. R.	0.19
New York, Westchester & Boston ..	2.56
Northeast Oklahoma R. R.	4.00
The Oshawa Railway (Canada) .	0.31
Niagara Junction Railway	1.02
Total	8.08

No reconstruction of track reported.

What A. A. E. Did in 1921

The accomplishments of the American Association of Engineers in the past year are summarized as follows by C. E. Drayer, Secretary.

No other year in the life of the American Association of Engineers has seen such a growing strength through teamwork. This is particularly well manifested in the various constructive activities of the chapters. While the chapters render service primarily to their local communities and the engineers in them, there was a marked increase in consciousness that through this community work, service is being rendered the nation and the engineering profession as a whole.

In voicing the views of engineers and broadening their field, over three hundred columns of newspaper publicity appeared. In Feburary, the first National Conference on Engineering Publicity was held, bringing together some of the keenest publicity minds of the country, and the proceedings in book form are now on the press.

In national public service the Association supported the reorganization of the departments of the Government on a basis of greater efficiency. A pamphlet, "Reorganization of the Government Departments," was published and attracted considerable attention.

As a public service, and also in accordance with its policy to encourage engineers to seek public office in which engineering ability may be utilized, the Association vigorously advocated the appointment of an engineer to the Interstate Commerce Commission. In this endeavor it was generously supported by engineers not members of A. A. E. and by other organizations.

The accomplishments of the chapters in the way of civic and public service were numerous. Public improvements were wisely advocated and directed in transportation, water supply, reclamation and conservation of resources.

In maintaining the pay of the engineer on a plane commensurate with his duties and responsibilities, the Association diligently strove through its Federal office, through the railroad sections, and through the chapters to prevent reductions in salary of government and railroad members. The annual conference of railroad sections was held in March. Through its Federal office the Association has cooperated very actively with Senator Sterling on the Reclassification Bill, tabulating data in graphic form so that existing conditions may be clearly shown to Congress, and so that while the increase in salaries might indicate an actual average of 5 per cent through the federal service in the district, the glaring inconsistencies needing correction were effectively brought to their attention. The Association has a committee on salaries of engineers in teaching service sitting.

In protecting the individual engineer from abuse, the Association contested successfully with several corporations against releasing engineer employes with less than two weeks' notice and has obtained general acceptance of the idea that two weeks' notice of release be given by both employer and employe. It has protected the word "engineer" against misuse by a corporation where "mechanic" should have been used. In several instances legal counsel has been extended to the individual member in need of protection.

In maintaining an effective employment service for the benefit of members during the year, notice of over 6,000 positions open were sent to all members that asked to receive them. Over 3,000 men were placed, about 2,000 through national headquarters and about 1,000 through the chapters. The annual saving to the members effected exceeded $300,000. A national committee was appointed and is now sitting with instructions to make plans for employment service truly national in scope, more nearly local in service, and adequately financed.

In maintaining ethical standards of conduct, the Practice Committee of the Association passed upon ten important cases and the findings have been approved by the board of directors. During the coming year the number and variety of cases will be increased so that by the end of 1922 a booklet may be published for the guidance of the profession and the public.

In elevating the plane of practice and protecting the competent engineer from unjust competition of dabblers and quacks, in requiring the man who wishes to practice engineering to appear before a legally constituted board, the

Association brought about the enactment of all-inclusive license laws in eight states. Thus far there are fifteen states with all-inclusive license laws, and five with some form of law. Bills were proposed last year in fifteen states but did not pass. While 1922 is an off year for legislatures, several bills will be introduced.

To help the practicing engineer in the solution of his problems the Association has a committee on services and fees of practicing engineers which proposes to hold a national conference during 1922.

During the year an outstanding change occurred in the assignment of responsibility and the division of receipts from fees and dues; 60 per cent was returned to the local units for their independent use. Work of national headquarters was reduced by discontinuing all special departments except employment, federal, and professional engineer.

The end of 1921 found the Association with 195 chapters and 61 clubs. The membership December 1, 1921, was 22,299, of which 2,500 are students. Eight hundred new student members were added this fall.

Cost of Ballasting with Slag

In a report of the Committee on Ballast of the American Railway Engineering Association in the September bulletin of the Association, the following data on ballasting track with 8 in. of slag placed under the ties are given. The information, obtained from a questionnaire sent out by a subcommittee, relates to the work on one railroad.

Table 1 summarizes the labor and material costs on six jobs. The figures do not include the cost of miscellaneous items, such as handcar turnouts, rail rests, etc.

TABLE I—COST OF LABOR AND MATERIAL FOR BALLASTING.

Job	(1)	(2)	(3)	(4)	(5)	(6)
Royalty		[illegible]	[illegible]			
Loading—measurement in car	[illegible]	[illegible]	[illegible]	$0.161	[illegible]	$0.195
Pit engine and switching	.068	[illegible]	[illegible]	.045	.054	.054
Hauling	.194	[illegible]	[illegible]	[illegible]	[illegible]	.305
Unloading	[illegible]	[illegible]	[illegible]	[illegible]	.004	.004
Skeletonizing	.083	.053	.053	.042	.058	.047
Spacing, etc.	.024	.012	.012	.005	.003	.003
Raising	.120	.073	.090	.094	.094	.090
Surfacing, lining and dressing	.147	[illegible]	[illegible]	.111	.102	.102
Cost per cu. yd. in track						
[illegible]	$0.749	[illegible]	[illegible]	$0.754	$0.756	$0.801
No. cu. yd. per mile	2,600	[illegible]	[illegible]	2,600	2,500	2,600
Cost per mile ballast in place	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	$2,084
No. ties inserted per mile	[illegible]	1,221	[illegible]	[illegible]	[illegible]	1,261
Average cost per tie	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	$1.07
Average cost per tie inserted	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	$0.086
Average train haul, miles	225	[illegible]	[illegible]	[illegible]	100	130

Job. No. 1 covers the ballasting of 20 miles of main line track between M. P. 229½ and 249½. The slag was loaded by contract at 13 ct. per cubic yard for first 20,000 cu. yd. and [illegible] ct. per cubic yard for remainder, pit measurement. The contractor furnished all powder, labor and steam shovel for loading. The company furnished pit engine and crew. The work was done from August, 1912 to March, 1913, inclusive.

Job No. 2 covers the ballasting of 15 miles of track between M. P. 23.66 and 38.66. The slag was loaded by contract at [illegible] per cubic yard, the contractor furnishing all powder, labor and steam shovel for loading. The company furnished pit engine and crew. The slag was procured from dump of smelter at a royalty of 19 ct. per ton. The work was done from July, 1913, to January, 1914.

Job No. 3 covers ballasting [illegible] miles of track between M. P. [illegible] and M. P. [illegible]. The slag was loaded by contract at [illegible] ct. per cubic yard, the contractor furnishing all powder, labor and steam shovel for loading, and the company furnishing pit engine and crew. The slag was procured from dump of smelter at a royalty of 19 ct. per ton. The work was done August, 1913, to January, 1914.

Job No. 4 covers ballasting 20½ miles of track between M. P. [illegible] and M. P. [illegible]. Slag loaded on cars by contract for [illegible] ct. per cubic yard, pit measurement. Work done February to June, 1914.

Job No. 5 covers ballasting 17.67 miles of track between M. P. [illegible] and [illegible]. Slag loaded on cars by contract for [illegible] ct. per cubic yard, pit measurement. Ballasting done April to July, 1914.

Job No. 6 covers ballasting 25 miles of track between M. P. 74 and M. P. [illegible]. Slag was loaded on cars by contract for [illegible] ct. per cubic yard, pit measurement.

Proper Handling of Ties

Useful suggestions on piling and distributing cross ties were given by F. S. Pooles, tie agent of the Chicago, Milwaukee & St. Paul Ry., in a paper presented at a recent staff meeting of the storekeepers of the railway. The notes following are taken from his paper.

Piling Ties on Right of Way. The grass and weeds should be cut away for some distance on all sides of the piles, as not the least of the enemies of the cross tie is fire, particularly in the spring and autumn seasons, when vegetation is dry and easily ignites.

The supports for tie piles should be either of sound timber, or preferably stone or brick, as rotten supports are a menace to sound timber the same as a case of smallpox or scarlet fever is a menace to people who are near it. The ground must be well drained. The factors necessary to decay are moisture, heat and air. We cannot exclude the heat or air, but careful piling will eliminate moisture to a considerable extent. Track men omit one of the supporting ties of top tier and pile the ties closely together to form a slanting roof or water shed over the ties.

When ties are stored any length of time, it is desirable to pile them as closely together as possible, consistent with a free circulation of air, but they never should be piled in solid ranks like cord wood or stood on end. Protecting the ends of ties in piles from the direct rays of the sun prevents checking and splitting.

Small "S" shaped irons are often driven into the ends of ties across a season check to prevent further splitting. This device costing applied less than 5 ct., often saves from 75 ct. to $1.00 per tie.

Distribution of Ties. It is important to use the right tie in the right place. It is not economy to use cedar ties or soft wood treated ties on portions of the road where traffic is heavy, or where there are many curves, because in such cases the ties are destroyed by mechanical wear long before the expiration of their physical life. For this reason, in recent years at least, we are as far as possible, using soft ties on the lighter or branch lines, sending white oak, treated hard maple, red oak, etc., to the large terminals or to our heavy traffic lines. Cedar, or other soft wood ties can only be used to advantage under heavy traffic when protected by good and sufficient tie plates, and even then, their use in such locations is questionable. In other words, we may state as a general rule, that in order to get the maximum life out of a cross tie it must be protected either by mechanical devices or by location to the limit of its physical life.

Another question in regard to the distribution of ties for repairs is whether in the case of ties coming from another division or from points off our line of road, should be unloaded from cars directly to the point on right-of-way where they are to be used for repairs, even if between stations, or whether such ties should be unloaded and piled at stations and moved to points where needed on push cars. The latest and most approved practice would seem to indicate unloading of ties at stations where they can be cribbed up in a sanitary manner and where they can be easily inventoried, moving them to points where they are to be used as needed.

Census of Safety Workers

How many persons are engaged in preventing accidents and promoting good health in the engineering and contracting and the building supplies field? Although it is known that engineers and contractors have taken a deep interest in safety work in the past few years and have accomplished great things in the prevention of accidents, there is nothing to show how many men and women have been responsible for this work in these fields as a whole. The National Safety Council is now taking a census which, when completed, will reveal how many safety workers there are. This census will include all persons engaged in safety and industrial health activities in all industries and those who are doing public safety work as well. The results of the census will show how the engineering and contracting and the building supplies fields compare with other industries in respect to the number of persons engaged in safety and health work.

This is the first time that any attempt has ever been made to list the thousands of persons who are now professionally engaged in the safety movement. The census includes not only members and employees of members of the National Safety Council, but all persons engaged in safety and industrial health activities regardless of whether they are connected with the Council in any way or not.

Every reader of this publication who is professionally engaged in industrial or public accident prevention or industrial health work—whether he is devoting all or only part of his time to accident prevention—can assist in the taking of this census by filling in the following form and sending it to the National Safety Council, 168 North Michigan avenue, Chicago:

Name ....
Company or organization ..
City .... State
Nature of company's business . .
Is safety your principal work? . ...

Please check other activities you engage in:

Fire protection
Health and sanitation
Workmen's compensation and claims
General executive (such as manager or superintendent)
Engineering (other than safety)
Legal
Insurance
Welfare
Education
Industrial relations

How long have you been in your present position?
Technical or other special education? ....
Signed ....
Title . ...

Railroad Construction in 1921

New line construction in 1921 showed an increase over the mileage of 1920 according to statistics compiled by the Railway Age. During the year 475.10 miles of new line were completed, which in comparison to the low record for 1920 of 313.71 miles is an increase of about 45 per cent. It is, however, far below the mileages built previous to the World War and from about two-thirds to one-half of that built each year during the four years previous to 1920.

Total mileage (first, second and other multiple main track) also increased in 1921, reaching 642.22 miles, of which 143.07 and 25.26 miles were second and third track respectively. This multiple track construction is an encouraging increase over 1920 when but 414.35 miles of all track were completed, of which 90.87 and 1.89 miles were second and third track. Other railway construction was concerned almost entirely with the completion of a few large projects and a number of small ones started in previous years. Little new work of any size was inaugurated during 1921.

In Canada there was a considerable decrease in total mileage constructed as compared with 1920 and almost no building of second and other multiple track work. With 251.48 miles of first track and 6.57 miles of second, Canadian mileage came close to its low record of 1918.

The longest stretch of line was that constructed by the Government Railroad of Alaska—81.95 miles. The remaining first track mileage was, in the main, divided approximately among seven states, with Texas leading with 63.6 miles and Florida next with 59.9 miles.

The following table reprinted from the Railway Age shows the mileage of new track built in 1921 in the various states:

NEW TRACK BUILT IN 1921

United States	Number companies building.	Miles first track.	Miles second track.	Miles third track.	Total
Alaska	1	81.95		...	81.95
Arkansas	4	13.59	2.00	...	15.59
California	4	5.27	1.19	...	6.46
Florida	4	59.90			59.90
Georgia	2	4.80			4.80
Hawaii	1	10.00			10.00
Idaho	1	7.54			7.54
Illinois	1	.....	3.30		3.30
Indiana	2	4.77	33.80		38.57
Kansas	2	0.75	9.65		10.40
Kentucky	3	1.57	5.50	10.60	17.67
Louisiana	1	7.81			7.81
Maryland	1	..	2.30	..	2.30
Minnesota	1	3.00			3.00
Mississippi	3	7.90	0.80		8.70
Missouri	4	4.09	8.23	0.60	13.03*
Montana	1		2.90		2.90
Nebraska	1	14.06			14.06
New Jersey	1	1.90			1.90
New York	1	....		13.30	13.30
North Carolina	2	48.00		....	48.00
Ohio	2	....	8.85	0.95	10.48†
Oklahoma	5	44.92		....	44.92
Pennsylvania	3	5.52		0.35	5.87
Tennessee	1	6.00	...	.....	6.00
Texas	4	63.60	2.17	.....	65.77
Utah	3	12.82	11.19	.....	24.01
Washington	1	3.50		.....	3.50
West Virginia	5	44.90	21.52	.....	66.42
Wyoming	1	16.94	29.13	.....	46.07
Total	66	475.10	143.07	25.26	642.22
Canada	10	151.28	6.57	.....	157.85

*Includes 0.11 mile of fourth or more track.
†Includes 0.68 mile of fourth or more track.

Wages for Hewing Ties

Some interesting information on the prices of hewn railroad ties and wages of choppers are given in a recent issue of the American Lumberman. We quote as follows:

Prices for tie making vary over the country, depending on whether producers really want ties made or whether they are merely supporting their particular territory by paying very low wages for such ties as are made rather than closing down operations altogether. One southern railroad recently quoted the following prices it would pay for Grade 5 7x9x8 ties on its right of way:

White oak	30 ct.	Red oak	30 ct.
Heart pine	40 ct.	Sap pine	20 ct.
Heart cypress	60 ct.		

In the Pacific northwest one organization reports the following prices paid tie makers:

6x7 ties	15 ct.	7x8 ties	25 ct.
7x7 ties	20 ct.		

Another organization states that the last scale known for hewn ties was 28 to 33 ct. for No. 1 ties. In the Pacific northwest railroad purchasing agents state that if they were in the market for hewn ties they would probably pay 45 ct. for No. 1 (7x9) hewn ties; and 35 to 37 ct. for No. 2 hewn ties (7x7; 7x8).

A careful investigation made on behalf of the American Lumberman by another western man developed the fact that prices paid choppers in various parts of Montana vary according to whether No. 1 or No. 2 ties are hewn. What is termed the weighed average price paid choppers varies from 17 ct. to 19 ct. a tie. In Montana they are paid according to the following schedule:

7x6	12 to 15 ct.	7x8	18 to 20 ct.
7x7	16 to 18 ct.	7x9	22 to 25 ct.

In Wyoming camps a new schedule of prices has been adopted since Oct. 15. A No. 2 tie is defined as one with a 6-in. face and 7-in. thick. A flat rate of 9 ct. a tie is paid choppers in Wyoming camps for the No. 2 ties and a flat rate of 18 ct. each is paid for No. 1 ties. In order to be paid at the rate of 18 ct. a tie, however, choppers may hew ties to any of the following dimensions: 7x7, 7x8, 7x9, or 8x8, 8x9.

The prices paid for ties by the Union Pacific R. R. Co., according to the best information available and which has been checked up at various points is 89 ct. plus 2 ct. for loading or 91 ct. f. o. b. cars.

Tie operators in Wyoming are paying 8 ct. for stumpage; 10 ct. minimum for hauling to banks of creeks; 20 ct. minimum for driving to railroad; 2½ ct. for loading on cars, and the stream improvements and the building of roads and camps is estimated at an additional 10 ct. a tie. The tie hazard is said to be large. This estimate which is fairly accurate does not include overhead, or losses on bad accounts, sinkage in river, losses at booms, losses due to minor thefts nor the rejects by the railroad company.

News Letter

ST. LOUIS ITEMS.

By A. B. Koenig.

M. L. Windham has moved a shovel outfit on to a new Illinois Central job in Kentucky.

Wm. O'Neil Sons Co., Faribault, Minn., have 40,000 yd. of road work at Wayne City, Ill., to sublet.

Appropriations totaling over $200,000 for street paving have been voted by the city council of Alton, Ill.

H. J. Massman is doing some riprap and shore protection work for the Missouri Pacific R. R. in western Kansas.

Robt. J. Oliver & Co., 5630 Pershing Ave., St. Louis, Mo., have 15,000 yd. of wheeler work at Mexico, Mo., to sublet.

J. J. McCaughey Co., Chicago, was awarded a 3-mile cut-off and track laying in Kentucky by the Illinois Central R. R. Co.

F. W. Hoyt of the Hercules Powder Co. reports a nice business. Hoyt is always on the job in the Railway Exchange Bldg. here.

Ira J. Printy has moved a machine outfit to Johnston City, Ill., where he is building a reservoir that he subbed from the Katz Const. Co.

St. Clair County, Illinois, will construct 28 miles of new roadway immediately. D. O. Thomas, Belleville, Ill., is superintendent of St. Clair County.

Dudley & Orr of El Paso, Tex., secured contract for grading and bridging 47 miles of railroad in Mexico. Work is to be finished in 150 working days.

A. L. Cook is going to do the team work on the C. R. Cummins job at Denison, Tex. Cook will place some of the outfits he has in Texas on this job.

Z. C. Mitchell of the L. J. Smith Construction Co. has fully recovered from his recent illness. Mitchell was here looking over the Missouri Pacific work.

Contractors when in want of work or labor for their outfits write Koenig Labor Agency, 612 Walnut St., St. Louis, Mo., or 501 Delaware St., Kansas City, Mo.

R. T. Amis of Kansas City is scouting around for a team job for his outfit which is about idle. Address him care of Koenig Labor Agency, 501 Delaware St., Kansas City, Mo.

[illegible]

[illegible]

[illegible]

[illegible] Ill., as [illegible]

[illegible]

[illegible] will be let over the [illegible]

The [illegible] of the Walsh [illegible] several days [illegible] they have [illegible] neighborhood [illegible] to look over [illegible] Were [illegible] old and [illegible]

[illegible] build an extension to [illegible] of $[illegible] will start as soon as [illegible] can be prepared and contracts awarded. The new addition will be used in the manufacture of [illegible] First National [illegible] Washington Ave., St. Louis, Mo., is [illegible]

[illegible] J. Woodrow, chief engineer of the Texas Highway Commission, has accepted the post of adviser in road matters to [illegible] of the Missouri State Highway Commission [illegible] which Gov. [illegible] has said he [illegible]. The commission also will have a [illegible]

[illegible] Alfred O'Leary of East St. Louis, Ill., in [illegible] department of streets and sewers, announced plans for improvements to cost $1[illegible] in the streets and sewers of [illegible] 1922. The improvements are divided into three [illegible] as follows: [illegible] extensions of the sewers [illegible] improvement of [illegible] 3rd St. east to the city limits, $[illegible] improvement [illegible] streets and elimination of railway grade crossings, $[illegible]

[illegible] will be spent for public and semi-public works in [illegible] 1922. The City Council has voted for street paving [illegible] and expansion [illegible] water system will require $[illegible]. The Illinois [illegible] improvements here and the construction [illegible] line from Herrin to Carbondale, for [illegible] of Herrin have subscribed $[illegible] will involve [illegible]

[illegible] contracts for constructing three [illegible] of the Norborne [illegible] Mo., have been awarded [illegible] to [illegible] & Williamson of [illegible] and the [illegible] Mo., at [illegible] the [illegible] method and [illegible] Feb. 1st.

[illegible] awarded contract [illegible] freight terminals by [illegible] Texas R. R. Approximate quantities 400 [illegible] culverts, 57 [illegible] and other [illegible] Hatfield and D. A. [illegible] on this job. It [illegible] ments will require the expenditure [illegible]

[illegible] of the National Crushed Stone Association [illegible] Hotel, Chicago, on Jan. 16, 17 [illegible] Quarry Co. [illegible] On the [illegible]

[illegible] Little Rock, [illegible]

[illegible] Walsh [illegible]

[illegible] construction of 54 miles of [illegible] expected to show a new [illegible] without cement [illegible]. The trouble in places [illegible] the cost of [illegible] department of highways [illegible] was submitted [illegible] & Co. [illegible]. The bid [illegible] the estimate and the contract [illegible] awarded. Three previous bids [illegible] were rejected because the price was too high. The gap [illegible] and when the pavement is [illegible] it will complete the [illegible] between Springfield and St. Louis. The lowest bid for [illegible] six miles in Adams County, Section 2, was [illegible] & Stanley of Quincy. It was for $128,[illegible]. For about [illegible] of road in Section [illegible] county, the lowest bid [illegible] by Alzina Construction Co. of Springfield. The lowest [illegible] bid for Sections [illegible] was made by Gill & Stanley [illegible] bid was $228,920. [illegible] also showed the lowest [illegible] miles in Jefferson and Wayne Counties, Section [illegible] made by the Alzina Construction Co., Springfield. [illegible] for 5.5 miles in Section [illegible] Wayne County, was $[illegible] approximately five miles in Section 18, Wayne County, [illegible] by M. Hayes & Son of Janesville, Wis.

Personals

Harry Myers has been appointed city engineer of Pittston, Pa.

Walter S. Craven has been appointed city engineer of Ogden, Utah.

R. Walter Jarvis has been appointed superintendent of parks of Indianapolis, Ind.

Paul Latchem has been appointed city engineer and street commissioner of Wabash, Ind.

Lester E. Prouty has been appointed county highway engineer of Mobile County, Alabama.

J. F. Rodenbough, Ottumwa, Ia., has been appointed county engineer of St. Johns County, Florida.

William T. Jackson, vice president and treasurer of Joseph Jackson & Son Co., contractors, has been appointed director of public service of Toledo, O.

Robert Clark Hill, of Redden, Del., who for the last three months has been acting as county engineer of Sussex County, Delaware, was elected engineer for 1922.

Col. James Costello has been appointed division superintendent of the county roads department of Allegheny County, Pennsylvania, succeeding Albert Simons, deceased.

R. F. Kelker, Jr., M. D. Gates and C. E. De Leuw announce the dissolution of the firm of Kelker, Gates & De Leuw, of Chicago, effective Jan. 1, 1922. The new firm of Kelker, De Leuw & Co. will take over all current contracts except the Platte Valley Drainage District of Worth County, Mo., and the Upper Salt Creek Drainage District of Logan County, Ill., which will be handled by Mr. Gates. Kelker, De Leuw & Co. will engage in general municipal and sanitary engineering, with offices in the Conway Bldg., Chicago.

Joe S. Boggs, State Highway Engineer of Kentucky, has announced complete reorganization of the divisional engineers' offices in his department, effective Jan. 1. Divisions are reduced from nine to six. The districts, with engineer and assistant in charge, and headquarters, are as follows: No. 1—S. J. Boone, engineer, R. R. Elliott, assistant, Paducah; No. 2—H. D. Palmore, engineer, C. T. Herndon, assistant, Bowling Green; No. 3—M. D. Ross, engineer, James W. Norton, assistant, Covington; No. 4—T. B. Smith, engineer, F. H. Yancey, assistant, Winchester; No. 5—J. S. Watkins, engineer, W. M. Jervis, assistant, Pineville; No. 6—M. E. S. Posey, engineer, R. W. Watts, assistant, Ashland.

Obituaries

James Walsh, railroad builder and financier, died Jan. 11 at his home, 60, Rush St., Chicago, aged [illegible]

Tom Hind, who had been associated with the late Col. Epes Randolph of Tucson, former president of the Southern Pacific de Mexico and the Arizona Eastern R. R., as construction engineer on a number of projects, died [illegible] in Houston, Tex. Mr. Hind was superintendent of construction of new lines of the Southern Pacific de Mexico near [illegible] Sonora, until a few weeks ago when he was appointed superintendent of an oil company.

Silas W. Titus, civil engineer, died Jan. 7 at Brooklyn, N. Y., aged 72. At the age of [illegible] he joined the engineering force of the New Orleans, Mobile & Texas R. R. Later he moved to the frontier of Texas, where water was scarce, and began the study of underground water supply, developing and constructing 12 wells in the vicinity of St. Angelo. Coming east in later years he established an elaborate [illegible] system at [illegible], Long Island, from which Brooklyn was supplied with water. In 1912 the city bought the plant.

John T. Ganey, contractor, died Jan. 9 at Canandaigua, N. Y. About 25 years ago he became a member of the contracting firm of King, Rice & Ganey of New York. Six or seven years ago Mr. King retired from the firm, the business being continued by Mr. Ganey and Joseph Rice. The firm engaged in subway and tunnel work in New York, Jersey City, Philadelphia, Baltimore and other large cities. Recently the firm was awarded a contract of over $[illegible] to build an addition to the New York aqueduct. Mr. Ganey expected to go to New York in the spring to superintend the work.

Trade Publications

The following trade publications of interest to engineers and contractors have been issued recently:

Crane.—Industrial Works, Bay City, Mich. Catalog devoted to new "Industrial" crawling tractor crane of 20,000 lb. capacity.

Motor Trucks.—Tiffin Wagon Co., Tiffin, O. Bulletin on 1½ to 7 ton motor trucks, containing illustrations and specifications.

Tractors.—Holt Manufacturing Co., Peoria, Ill. Bulletin illustrating and describing use of Caterpillar tractors in snow removal.

Earth Handling Machinery.—Bay City Dredge Works, Bay City, Mich. 32 page catalog illustrating and describing crawler, track and floating dredges, sand and gravel loaders, cranes, clay excavators and other excavating machinery.

Lubrication of Steam and Oil Engines.—Vacuum Oil Co., 61 Broadway, New York City. Two booklets prepared by the technical department of this company, one dealing with the stationary steam engines and the other with oil engines of the surface ignition type.

Building and Structural Monthly Issue

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Managament and Office System

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E. & C. Index Furnished Only on Request

The index for Vol. LVI—July-December, 1921—issues of Engineering and Contracting is now being prepared. In common with many other publishers we have adopted the practice of sending the index to only such subscribers as request it. Therefore, if you want the index for the last 6 months you should notify us at once. Those who requested the index for the previous volumes have been listed and need not notify us again.

Should Passenger Stations Be Architectural Monuments?

It was the late Charles Mulford Robinson, if our memory serves us correctly, who first suggested that as the gate to the walled city of other days was a monumental thing, symbolizing the strength and magnificence of the city, and impressing them alike upon stranger and citizen as they passed, so should the modern passenger station be planned to impress arriving and departing travelers.

In this suggestion we believe that Mr. Robinson was right. The fact that he sometimes appeared—particularly to the hard headed engineer—as an impractical idealist does not brand all his great conceptions as flights of fancy, impossible of realization.

This suggestion of Robinson's is called to mind by the announcement that the new union passenger station at Cleveland is not to be of the monumental type. We are not sufficiently familiar with the Cleveland situation to criticise the decision in the particular case. The great cost of the indispensable features of the station, the present hard-up condition of the railroads, or other reasons may justify the limitations imposed; but the necessity for them is a proper subject of regret, and it is to be hoped that similar necessities will not arise in other cases.

As we see it, the logic of the monumental railway station and of most other public and quasi-public structures is this: America's productive power is now vastly beyond that necessary for the mere supplying of the physical needs of food and shelter. The excess, quite obviously, is spent for the most part on pleasures and luxuries; and of these, few indeed are as thoroughly wholesome as is the enjoyment of beautiful architecture.

The theater and the high class hotel are made beautiful as a business necessity. No one questions that they should be so; but for other buildings there is often criticism—"These gorgeous bank buildings show that the banks are making too much money." "Why don't the church people help the poor instead of spending their money for steeples and colored windows?" "The railways ought to lower their rates instead of building depots like palaces." The reason that such criticisms receive and deserve so little attention is that they approach the subject at the wrong point. If it were true that the money saved on imposing architecture would be turned to the benefit of those most in need, we should say, "Right! Let us postpone such luxuries until all people are supplied with the more vital things." But neither business nor personal ethics in America has as yet reached so high a plain. It is inconceivable that the curtailing of these "luxuries" would materially benefit the people most in need of help. In fact we think it most likely that whatever savings might be made would be spent in ways of less benefit to the poorer citizen. We grant the need of a better distribution of wealth and income, but not the need of dispensing with the beautiful and inspiring in order to get it. Limitation of the railway station is a particularly inconsistent way of improving distribution, because the station is so completely a place for the equal use of rich and poor. It may even be the only building of magnificence entered by some of the latter; and we think that its influence is good, for the poor man has not merely the privilege of looking at it; he actually uses it; and if he is a man of appreciative sense and feelings, he takes pleasure in the knowledge that it is intended for [illegible]. How many commuters have not certain feelings of proprietorship and pride in the fine station through which they pass daily? One can note the pride in the way they [illegible] and the proprietorship in the references to it as "our" or "their" depot.

We hope that there will not be many new stations or other public buildings limited by necessity to "purely utilitarian" requirements.

Labor Leaders and the Landis Award

From an employers' standpoint, under Judge Landis' arbitration the settlement of the labor disputes in the Chicago building trades has passed through phases of complaint, hesitation and refusal to abide by the agreement until now but [illegible] of the more than 50 unions involved remain loyal to the arbitrator's decision.

The breaking away of the unions has been progressive. [illegible] and vacillating at first, one union after another has eventually lined up with the Chicago Building Trades Council (the electricians, bricklayers and ornamental iron workers not being represented at the deciding meeting) as now on record as actively opposing the arbitration award. As to the breach of faith involved we have at this time nothing to add to what we have already said, but there are comments to be made upon certain circumstances and recent developments of the case.

It is difficult to escape the conclusion that bad leadership and intimidation are responsible for the final swing of the unions, and after the disclosures of last summer's graft investigations both in Chicago and New York, it is amazing that such leadership should be retained. Our belief is that man for man, union members average about the same as other Americans in intelligence and integrity; which means that they often err in judgment, are subject to prejudice, and are very largely selfish, but that withal they have a sense of honor, and would much rather do right than wrong.

How it happens that organizations of such average men are so often swung from the paths in which their individual better judgments and inclinations lead them, is a psychological problem not to be solved here. But in the face of the more than ample evidence that many of their leaders have been so corrupt as to exploit the unions for their own benefit, their actions in some instances extending to plain robbery, there is a surprising lack of any active spirit of purification.

At the Chicago meeting which repudiated the Landis award there was an election of new officers which is said to indicate the ascendancy of "Big Tim" Murphy in union affairs. How great Murphy's power in the unions may be we do not know, but his entrance into the hall was greeted with loud cheering. "Big Tim," it is to be remembered, is now at liberty under bond, pending an appeal from his conviction some months ago of conspiracy to rob the United States mail. It is particularly unfortunate for labor that Murphy should appear in such a light, for he is a man who is believed by a large part of the community to be thoroughly bad and guilty, though unconvicted, of other serious crimes.

Union labor seems in many instances to be stagnating in bad leadership. It does not throw off the incubus, and of late it has been losing some of the prestige and sympathy which it so hardly won through many years of effort. The turn of public sentiment has been unmistakable and it will go further unless conditions are improved. Its essentially right desire to better the condition of its members has led [illegible] to attempt too much, and to use bad methods in many cases. It has been as disregardful of the welfare of others as others often have been of its welfare, and the public has not been blind to these facts. In its own interest unionism's first act should be to eliminate from leadership all men whose [illegible]. That is not the only problem of leadership, for [illegible] and bigotry also [illegible], but the most [illegible] present need is for purification.

Study of Colloidal Material in Clay.—In the course of the [illegible] studies being conducted at the Columbus station of the U. S. Bureau of Mines, colloidal material in clay has been separated and is being studied both qualitatively and quantitatively, the ultimate aim being to determine the effect of the colloidal material found in clay on plasticity.

The Elongated City

Undoubtedly, whether consciously or unconsciously, either the square or the circular form stands in the eyes of most people as the ideal outline for a city; while the frontier town straggling out on both sides of its long "Main Street," is held as just about the ultimate of civic ugliness and inefficiency.

Without going deeply into the theory of city planning, we would point out that the advantages are not all on the side of the more compact forms, and that where new projects or extensions permit of sufficient control and guidance, the elongated plan may actually possess the greater sum total of merits.

Of course if the prime object is to have every point within the city as close as possible to every other point, the circle is the correct figure, with the square as a reasonably close second. For the sake of convenience, let us limit our references to the circle, and consider that all of its relations to which we may refer have close and obvious counterparts in the square.

The grouping of the city's developments within the circle will be essentially either on zones like the rings of a target or on sectors or on fractional combinations of these. In general the center will be occupied by the retail store and office business, with various combinations of industrial, residential and mixed occupancy grouped about it in imperfect zones and sectors.

Usually the worst combination of different uses is that which brings a residential area into direct contact with a manufacturing area, railroad yard or the like, but the circular form of itself conduces to these very contacts. The best that can be done with them is to extend narrow parks between the incompatible areas or to develop secondary retail streets as lines of separation. Either of these courses will be unsatisfactory at times, or perhaps even impossible.

The city which is developed in more or less parallel bands instead of in portions of a circle, has the advantages of a quite natural separation of its areas, and an arrangement permitting of growth without the development of objectionable contacts. Although in any sizeable community there would be certain variations and many minor subdivisions, three principal zones or bands would be in evidence as comprising the residential, business, and industrial districts. The business district would separate the other two, and each of the three could grow at both its ends without any tendency toward conflict. Admittedly it is not a compact arrangement, but with perhaps a few exceptions, extreme compactness is no longer either sought or desired for a city as a whole. Modern transportation more and more appears as a revolutionizer of our environment and manner of life.

Longitudinal streets of special width, probably divided for the accommodation of different classes of traffic would of course be necessary features of such a plan. In the ideal city, each person would live approximately opposite his place of business or work, and in going to and from it, would for the most part follow a lateral street either into the business district or across it to the industrial section.

Of course no one expects that any city is going to be built on quite such simple lines as these. There will be variations required by topography; local business centers in the residential district will still be necessary in some cases, although the elongated plan will reduce such requirements; prior developments and established lines of communication will be of great effect; and other influences will doubtless complicate the situation. It is by the consideration of such ideals that the modern science of city planning is developing.

These are mere suggestions in the search for an ideal—a sort of friendly chat wherein we hope not so much to impart knowledge as to stimulate the thoughts of both our readers and ourselves. The modern science of city planning, in spite of its great progress, is not yet complete; and there still must be much of mulling over generalities, of choosing and discussing and rejecting. Then, too, there are imperfections of tools and material as numerous and as varied as the imperfections of human nature. Wise city planning does not ignore these; rather it seeks to understand them, remedying the imperfections where possible, and where it cannot remedy, building the best possible with that which is available.

Book Review

The Design of Steel Mill Buildings and the Calculation of Stresses in Framed Structures. By Milo S. Ketchum, C. E., Director Department of Civil Engineering, University of Pennsylvania. Fourth edition, 632 pages, 6 by 9 in. Illustrated. McGraw-Hill Book Co., Inc., New York. $6.00 net.

While "Ketchum's Steel Mill Buildings" is too well known to require an introduction, the fact and the character of a new edition are matters of decided interest. The profusion, good workmanship and intelligibility of the drawings first catch the eye as the book is run over, and next to these is the neat and pleasing appearance of the printed page.

On investigating the more important features we find that it is divided into 3 parts, the first covering the calculation of the stresses in simple beams, trusses, portals, the transverse bent, and the three-hinged arch. Part II covers the calculation of deflections, the calculation of stresses in statically indeterminate girders, trusses and frames, and the secondary stresses in trusses. Part III treats of the design and construction of steel frame buildings for mines, mills, smelters, etc., and also the design of a crane girder. The appendix gives a complete specification for steel frame mill buildings. The index is good, although less complete than many users will desire.

Some of the subjects of the 40 chapters are as follows: "Graphic Statics; Stresses in Pins, Combined and Eccentric Stresses, Area Moments and Curved Influence Lines; Problems in the Calculation of Stresses in Statically Indeterminate Structures, Camber, etc.; Data for Design of Framework; Roof Coverings; Foundations; Erection of Steel Mill Buildings; Estimate of Weight and Cost of Steel Mill Buildings.

Prof. Ketchum's thoroughness and clearness of style have not suffered since the last preceding edition, and apparently the same scrupulous care as heretofore has been used to insure freedom from typographical, mathematical and other errors. The book is announced as a companion to the author's "Structural Engineer's Handbook," but each of the two is independent of the other.

Bracing of Structural Members

To the Editor: A few weeks ago the steel work of a theater building in Brooklyn collapsed and killed a number of men. Guesses are beginning to come in as to the cause of this wreck. Mysterious and trivial things are suggested as the cause: If a column that had no office whatever but to support a direct vertical load had had a knee brace the wreck would not have happened. If roof trusses had been designed with straight bottom chords instead of chords on a broken line, the design would have been good. The roof trusses should have been on rollers on a brick wall. These are some of the guesses. Poor brick work is also blamed.

As a matter of fact the fault in the design of this steel work is so glaring that it stands out as the most outstanding feature in the structure.

Before the days of reinforced concrete practically every structural wreck apart from dams (which nearly all fail because of under pressure) was due to the absence of bracing. One author of a book on dams, of comparatively recent date, starts his book with a warning against the danger of failure to consider under pressure in the design of dams. If every author of a book on structural steel design would give an emphatic warning against failure to provide bracing in a structure, there would be scarcely any steel structural failures, if the warning were heeded. If every book on reinforced concrete gave a warning against rodded columns and dependence on stirrups and short shear members to take end shear of beams and girders, there would scarcely be a single wreck to record, instead of 30 or more large ones, provided of course the warning were heeded.

The Brooklyn theater wreck is just another example of what may be expected when a designer fails to provide bracing in his structure. The roof of this theater had a row of trusses without a wire or a rod in the shape of either sway bracing or lateral bracing to prevent the whole row from flopping over and allowing the whole roof to collapse. This is exactly what happened.

Recently I checked the design of a good sized building that did not have any bracing. I criticized the design but the builder's engineer persuaded the owner that bracing was not needed. When it came to the erection of the building, it was impossible even to line it up. The necessity of bracing was so evident that the builders hurried rods and struts to the site by express. Had they not done this the first strong wind would probably have laid it low.

Pittsburgh, Pa. EDWARD GODFREY

The Engineer as a Manager

Frank discussion of the shortcomings of the engineer as an executive or administrator was brought out following the address of R. C. Harris, Commissioner of Works, Toronto, at the Toronto meeting of the American Association for the Advancement of Science. The engineer should make the highest type of administrator, said Mr. Harris, but by reason of native modesty or unsuitable training, he frequently fails to appreciate the economic features of the situation, and discloses inability to relate the creation of physical works to the value of the dollar. He has not generally had sufficient human contacts to make him a good executive, and, continued Mr. Harris, regards himself rather more as a builder or constructor than as a manager of men.

The qualifications of the engineer as a manager have been vigorously debated in the engineering press during the last few months, growing out of an address by Philip Cabot, member of a prominent New York financial house, at a joint meeting of the Founder Societies in New York last October. Mr. Cabot's strictures were severe. He characterized the engineer as scientific, studious, severe, ascetic, cool, cautious and unimaginative. "He is a man," said Mr. Cabot, "who curbs his enthusiasms, who does not allow his conclusions to be colored or influenced in the slightest by an idealistic or impulsive temper." According to Mr. Cabot, these characteristics render the engineer constitutionally unfit to lead or direct large industrial or public enterprises. He pictured the successful industrial leader as one having the capacity to inspire large bodies of men, and as the possessor of the promoter or salesman type of mind rather than that of the student or scientific investigator. He regarded the engineer as a hand which executes rather than a mind which directs and controls, and believed him to be an unpromising candidate for promotion to managerial positions.

Those who have risen to the defense of the engineer in these discussions have pointed out that while the promotional type of mind is useful, it is an exceedingly dangerous one unless carefully watched and guided. The enthusiast who sees everything in a rosy light is likely to wreck an enterprise much more quickly than the cool and unemotional engineer. It very frequently happens that the latter is called in to straighten out some of the financial and operating muddles that have been brought about by a manager of the promotional type.

The truth of the matter is that the management of industrial or other enterprises that involve dealing with a large force requires several characteristics or qualities of mind. Enthusiasm must be matched by cool and careful judgment. Wherever a man can be found who combines in himself the capacity to direct and inspire large bodies of men with sound technical and financial knowledge, his price is above rubies. Men of this type who have undertaken managerial work are not unknown. On this continent, two notable examples in recent years are General Goethals and Herbert Hoover, not to mention several of our fellow-Canadians who are successfully directing large undertakings at the present time. It will be interesting to survey the field in ten or twenty years and discover the effect of the increasing popularity of courses in administrative engineering. Once the idea of the suitability of the administrative field for graduate engineers has been thoroughly assimilated, and engineering students have been taught to appreciate the financial and managerial factors in an enterprise, as well as the technical ones, the number of engineers in managerial positions should increase very rapidly.

Already very considerable numbers of engineers are known to be occupying executive positions on this continent. At least six railroad presidents and five vice-presidents are engineers. Of the 230 city managers in Canada and the United States, about 75 per cent are civil engineers. Municipal rapidly appreciating the fact that the largest item of the city budget is associated with the department of works, naturally look to the civil engineer as likely material for a city manager. As long as it is possible to discover men who have not only sound technical knowledge, but sufficient executive and business capacity, a knowledge of municipal law and finance, and ability to explain clearly and precisely the civic policy to the citizens, city management should prove a likely field for the engineer. With the growing tendency for this form of civic government it is very probable that the engineer will be more and more frequently employed in public administrative posts.—Editorial in The Canadian Engineer.

In Favor of the Quantity Survey

Somewhere about 8 years ago Mr. G. Alexander Wright, a member of the Institute in the San Francisco Chapter, besought the interest of the Journal in the subject of Quantity Surveying. He was a pioneer in an unreceptive land. And now that he is no more and, like many another, did not live to see his long devotion bear any great fruit, let it not be forgotten that he was a pioneer and that because of the interview in question the subject of Quantity Surveying was never lost to sight again, so far as the Institute was concerned. We are proud of our share in the document which has been sponsored by the Institute, the Engineering Council, and the Associated General Contractors of America. It recommends the Quantity Survey to every owner, and very properly reminds him that he should not "pay a Contractor an overhead charge which includes any other costs than belong to his own project," and likewise that an Owner should pay for the preparation of an itemized list of quantities whether he proceeds with the contemplated project or not. Assuredly he should, and assuredly some owner does pay for them several times over, under the present system. The only man who gets anything free is the man who never builds, because all the expenses of nursing him through the preliminary approaches are saddled upon someone else. The overhead borne by the Building Industry, because of the supposed free service rendered, is no small item. Any man proposing to spend a considerable sum of money in building should insist on a Quantity Survey, as one of the most certain means of economy that he can employ.—Editorial in Journal of the American Institute of Architects.

Method of Transferring and Elevating Girders for a Bascule Span

In the construction of the Batiscan River bridge on the Quebec-Montreal highway, the two 62-ft. half through plate girders of the bascule span were transferred from the cars to the bridge site in the following manner. They were set 6 ft. apart, braced together by temporary braces and mounted on two axles with flanged wheels which moved along steel rails. A strong wood post was driven in the ground some distance ahead and a team of horses hitched to a cable passing through blocks supplied the tractive power. When the girders had traveled the distance to the post, this and the rails were re-set ahead and the operation repeated till the water edge was reached, where they were loaded on a scow. The scow was brought alongside Pier No. 5 in the morning and the derrick hoisted them up one at a time and placed them on their bearings so that both were in place before night. The rapidity with which the operation was performed, according to The Contract Record, was greatly due to the fact that the center of gravity of each girder had been very accurately located and marked beforehand, so that no time was lost in finding the right place for slinging, and they balanced perfectly well when being lifted up to the top of the pier.

Fabricating Shop Contracts.—The records of the Bridge Builders' & Structural Society, from reports collected by its secretary, show that during the month of December, 1921, [illegible] tons of fabricated structural steel was contracted for throughout the United States, equivalent to [illegible] per cent of the entire capacity of the bridge and structural shops of the country. The total tonnage sold in this country in 1921 was [illegible], equivalent to [illegible] per cent of capacity.

Index Numbers of Wholesale Prices 1913 to December 1921

The accompanying tabulation shows the index number of wholesale prices by groups of commodities, as computed by the U. S. Bureau of Labor Statistics. The group of miscellaneous commodities includes such important articles as cottonseed meal and oil, lubricating oil, jute, rubber, newsprint and wrapping paper, rope, soap, laundry, starch, tobacco, Manila hemp, sisal, phosphate rock and wood pulp. The commodities, composing the other groups, are as indicated by the title.

INDEX NUMBERS OF WHOLESALE PRICES IN SPECIFIED YEARS AND MONTHS 1913 TO DECEMBER, 1921, BY GROUPS OF COMMODITIES
(1913=100)

Year and month	Farm products	Food, etc.	Cloths and clothing	Fuel and lighting	Metals and metal products	Building materials	Chemicals and drugs	House furnishing goods	Miscellaneous	All commodities
1913	100	100	100	100	100	100	100	100	100	100
Jan.	97	99	100	103	107	100	101	100	100	100
April	97	96	100	98	102	101	101	100	98	98
July	101	102	100	[illegible]	98	101	99	100	101	100
Oct.	103	102	100	100	99	98	100	100	100	101
1914	103	103	98	[illegible]	87	97	101	99	99	100
Jan.	101	102	98	[illegible]	92	98	100	99	99	100
April	103	95	[illegible]	98	91	[illegible]	100	99	101	98
July	104	104	[illegible]	95	85	97	99	99	97	100
Oct.	103	107	[illegible]	[illegible]	83	96	105	99	96	99
1915	105	104	100	[illegible]	97	91	114	99	99	101
Jan.	102	106	96	93	83	[illegible]	103	99	100	99
April	107	105	99	[illegible]	91	94	102	99	99	100
July	108	[illegible]	[illegible]	90	102	93	108	99	98	101
Oct.	105	103	[illegible]	[illegible]	100	93	124	99	99	101
1916	122	[illegible]	[illegible]	119	148	101	159	115	120	124
Jan.	108	113	110	105	126	[illegible]	170	105	107	110
April	114	117	[illegible]	108	[illegible]	101	172	108	110	117
July	118	121	126	108	145	99	156	121	120	119
Oct.	136	140	[illegible]	[illegible]	151	101	150	124	132	134
1917	189	176	181	175	208	124	198	144	155	176
Jan.	148	150	161	176	183	106	159	132	138	151
April	181	182	169	184	208	114	170	139	149	172
July	199	181	187	[illegible]	257	132	198	152	153	186
Oct.	198	183	[illegible]	[illegible]	182	114	252	152	163	181
1918	220	189	[illegible]	165	181	151	221	196	193	196
Jan.	207	187	211	157	173	136	232	161	178	185
April	217	178	[illegible]	[illegible]	177	146	229	172	111	190
July	224	181	249	166	181	154	216	199	190	198
Oct.	[illegible]	201	257	167	[illegible]	158	218	226	196	204
1919	234	210	261	173	161	192	179	236	217	212
Jan.	222	207	234	170	172	161	[illegible]	218	212	203
April	235	211	217	167	152	162	178	217	216	203
July	246	216	282	171	158	186	171	245	221	218
Oct.	[illegible]	211	313	181	161	231	174	264	220	223
1920	218	[illegible]	302	[illegible]	136	308	210	366	236	243
Jan.	246	253	350	184	177	268	189	324	227	248
Feb.	237	244	356	187	189	300	197	329	227	249
March	239	246	356	192	192	324	205	329	230	253
April	246	270	353	213	195	341	212	321	238	265
May	244	287	347	235	193	341	215	329	246	272
June	243	279	335	246	190	[illegible]	218	362	247	269
July	236	268	317	252	191	[illegible]	217	362	243	262
Aug.	222	235	[illegible]	268	193	328	216	363	240	250
Sept.	210	222	[illegible]	284	192	318	222	371	239	242
Oct.	182	201	277	282	184	313	316	371	229	225
Nov.	165	195	[illegible]	258	170	274	207	369	220	207
Dec.	144	172	220	[illegible]	157	266	188	346	205	189
1921:										
Jan.	136	162	208	[illegible]	152	239	182	283	190	177
Feb.	129	150	198	218	146	222	178	277	180	167
March	125	150	192	207	[illegible]	218	171	275	167	162
April	115	141	186	199	[illegible]	[illegible]	168	274	154	154
May	117	133	181	194	[illegible]	202	166	262	151	151
June	113	132	[illegible]	[illegible]	132	202	166	250	150	148
July	115	124	[illegible]	184	[illegible]	200	163	[illegible]	149	148
Aug.	118	152	[illegible]	[illegible]	120	198	161	230	147	152
Sept.	122	146	[illegible]	[illegible]	120	192	162	223	146	152
Oct.	119	142	190	[illegible]	121	192	162	218	145	150
Nov.	114	142	[illegible]	[illegible]	119	197	162	218	145	149
Dec.	113	139	[illegible]	187	119	203	161	218	148	119

Convention of the American Concrete Institute.—The annual convention of the American Concrete Institute will be held Feb. 13-16 at the Hotel Winton, Cleveland, O. The program calls for reports, papers and discussions on the following subjects: Concrete roads, concrete houses, research, concrete products manufacture, practical field problems, engineering design and construction. The convention will be characterized by the fewness of its formal papers and by the comparatively large amount of time which will be given to the discussion of special reports and to the impromptu narration of practical experience on the floor of the convention. Harvey Whipple, 314 New Telegraph Bldg., Detroit, Mich., is Secretary of the Institute.

Ontario Parliament Buildings Nearly Completed.—It is estimated that the new parliament buildings at Ottawa, Ont., will be completed by Feb. 15, except for the central tower, which has still 128 feet to go. The entire cost of the new building up to Nov. 15 was $10,073,000.

Practical Side of Cold Weather Concreting

By THE TURNER CONSTRUCTION CO. of New York.

Experiences of One of the Largest Construction Companies in the Country in the Erection of Concrete Structures in Winter Months

Although a few years ago it was considered bad practice by engineers and unprofitable for contractors to continue concrete construction throughout the winter months, such procedure is now becoming common practice by the most successful contractors. It enables them to maintain a competent year-round organization, to take advantage of low winter prices and of the large supply of labor. It also enables the owner to occupy the building three or four months earlier than would be possible if construction stopped during the winter months.

It has long been recognized that low temperatures retard the hardening of concrete and that extreme cold prevents it all together. Realizing these facts and at the same time appreciating the many advantages of working through the winter, the Turner Construction Co. of New York City cites a series of experiments made in the Laboratory of University of Illinois and published in the proceeding of the American Concrete Institute to determine more definitely what effect low temperatures have on the rate at which concrete hardens.

Nine test cubes of 1:2:4 pebble concrete were subjected to the following tests:

The first three cubes after being stored in a temperature of 60° for 5 days, were subjected to compression tests. They had developed an average strength of 917 lb. per square inch. This is about normal strength for concrete 5 days' old.

The second three cubes were stored at a temperature of 60° F. for 5 days and for 14 days more at a temperature below freezing and then tested. The result showed an average compressive strength of 1,042 lb. per square inch or a gain of only 125 lb. in 14 days.

The remaining three cubes were stored at 60° F. for 5 days and for 28 days more at a temperature below freezing and then tested. The result showed an average strength of 1,063 lb. per square inch or a gain of only 146 lb. in 28 days. We should ordinarily expect test cubes stored in a temperature of 60° F. or over for 23 days to show a strength of over 2,000 lb. per square inch.

These tests prove without question that there is a considerable retardation of the rate of hardening at low temperatures and that concrete gains strength very slowly in cold weather even when first allowed to set for 5 days at a temperature of 60° F.

Further tests were made with 1:2:4 pebble concrete cubes which were stored for three months at a temperature below freezing. They were then all removed and stored at a temperature of 70° F. After storage for seven days at this temperature, some of these cubes were tested and showed no appreciable strength. Others were tested after a period of one month's storage at 70° F. and showed an average strength of 703 lb. per square inch when we should expect a strength of at least 2,000 lb. per square inch from normal 1:2:4 concrete.

This test shows the positive necessity of immediately protecting concrete as soon as it is placed and that concrete once frozen and then thawed out gains strength very slowly.

The foregoing facts leads to the following important conclusions.

First, concrete must be kept from freezing and must be kept warm for a period of 4 or 5 days before exposing to cold and that after setting at warm temperatures for 5 days it gains strength very slowly when exposed to cold temperatures.

Second, that as the concrete is still weak in compression when forms are removed, special care must be used to prevent excessive stresses while stripping and in depositing. Work started in the fall of the year or before spring or at such time that concrete must be placed in a temperature below freezing, should be considered winter weather work and should be protected accordingly.

For certain work such as footings, the roof of a building, or if the work will continue for only a short time in moderately cold weather only partial protection may be sufficient. Partial protection has been satisfactorily provided by heating the sand and pebbles over pipes inside of which fires are kept burning. After placing, the concrete may be covered with 1-ply tar paper, which in turn is covered with marsh hay, manure or canvas. In any case the frost must be removed from the aggregates and covering applied to retain both the heat supplied and that generated in the process of hardening.

When concrete must be placed in severe or protracted cold weather it will be necessary to provide sufficient canvas, salamanders and fuel for its protection. Lumber must be provided for frames and a boiler with sufficient steam hose, perforated pipes, etc., will be necessary to provide steam for heating materials.

The experience of the Turner Construction Co. has shown that for complete protection the most satisfactory method is to heat the aggregate and water with steam, cover the green concrete with tight canvas and place salamanders so as to cause circulation of heat around the concrete.

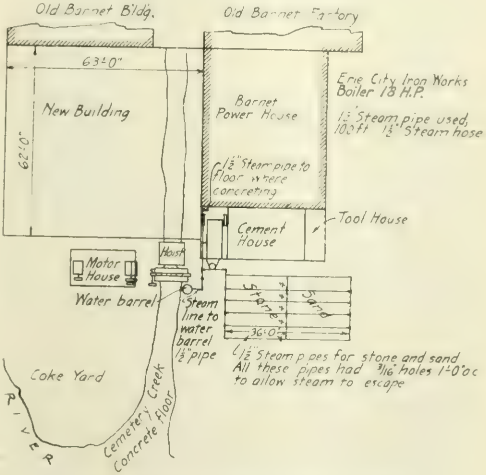

Old Barnet Bldg.
Old Barnet Factory
63'-0"
62'-0"
New Building
Barnet Power House
Erie City Iron Works Boiler 18 H.P.
1½" Steam pipe used, 100 ft 1½" Steam hose
1½" Steam pipe to floor where concreting
Tool House
Cement House
Hoist
Motor House
Water barrel
Steam line to water barrel ½" pipe
Stone
Sand
36'-0"
1½" Steam pipes for stone and sand All these pipes had 3/16" holes 1'-0" o.c. to allow steam to escape
Coke Yard
Cemetery Creek
Concrete floor
RIVER

Fig. 1.—Method of Heating Sand and Stone.

Before starting to mix the concrete, the superintendent should be positive that all aggregate is free from frost and has attained a temperature of from 35° to 50° F. The mixing water should be at a temperature of 100 to 150° F.

It has been found that a grillage of steam pipes is the most satisfactory method of heating sand and pebbles. A 1½-in. steam line is run from the boiler to the location of gravel and sand storage from which a grillage of 1½-in. pipes should be laid on the ground covering an area slightly smaller than the area to be covered by the storage pile. These pipes should be 4 ft. on center and should be perforated with 3/16 or ¼-in. holes staggered on 1-ft. 6-in. centers. (See Fig. 1.) Some trouble has been experienced from large grains of sand blocking up round holes and this may be avoided by cutting notches in the pipe with a hack saw at intervals of 1 ft. or 1 ft. 6 in. If the sand and gravel is stored in bins a grillage of steam pipes should be provided in the bottoms of the bins.

In case the pile of material will not be constant enough to warrant a grillage on the ground insert three connections in the steam main controlled by valves and attach to each connection a length of steam hose on the end of which attach a 6-ft. length of perforated pipe. This pipe should have one end closed and drawn to a point. Two of these perforated pipes should be driven into the gravel pile and one into the sand pile at the place where the carryalls are being loaded.

A 1½-in. steam line controlled by valve conveniently placed at the mixer should be run from the boiler to the water barrel, with the pipe extending down into the barrel to about 2 in. from the bottom in order to force live steam into the water.

A 1½-in. line should be run up the concrete hoist and a suitable valve and connection supplied at each floor level to provide for the attachment of steam hose for cleaning ice and snow from the forms and reinforcement.

For a large sized operation a 100 H.P. boiler carrying from 50 to 60 lb. of steam is required to furnish heat and if steam is used for cleaning snow and ice from the forms in addition to heating aggregates and gauging water a 50-H.P. boiler is the smallest practicable size for even a comparatively small job. However, on small jobs having not more than 5,000 ft. floor area on one floor an 18 to 25 H.P. boiler will give good results.

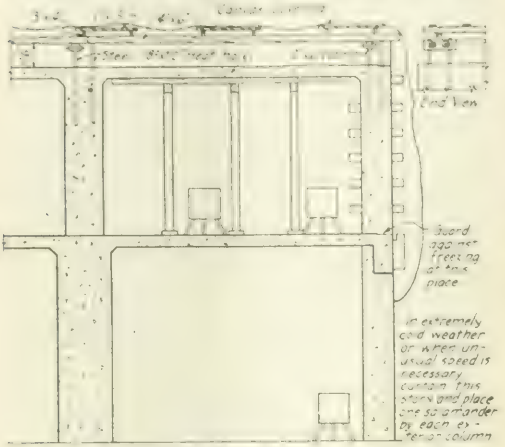

Canvas covering
Steel
End View
Guard against freezing at this place
In extremely cold weather or when unusual speed is necessary curtain this story and place one salamander by each exterior column

Fig. 2.—Method of Using Canvas Covering and Salamanders.

All ice and snow accumulated in the forms or on the steel must be removed before concrete is placed and special care should be taken to remove any snow or debris in the bottoms of the forms. Live steam should be run into the forms continuously ahead of the concrete to remove frost from the steel and every precaution must be taken to prevent the condensed steam from forming into ice again. Where a considerable area of steel is placed in advance of concreting it is advisable to throw canvas covers over it at night to guard against snow falling into the forms and under the steel.

Concrete of a stiff jelly-like consistency will gain strength more quickly than a wet mix and less trouble will be experienced with laitance. For this reason concrete placed in winter weather should be mixed with only enough water to permit proper deposition in the forms. The concrete should be placed in the forms at a temperature of not less than 50° F. When concreting at moderate temperatures scarcely below freezing, and when only partial protection is needed the concrete need not go into the forms at such a high temperature but absolute certainty must be had that the temperature of the mixture is always well above freezing and that the aggregate is absolutely free from frost.

The canvas used for covering should be lapped adequately and fastened together so as to be as nearly weatherproof as possible. A good practice is to support the canvas on wooden forms resting on the column reinforcement at about 18 in. above the finished concrete floor surface and hang canvas curtains from the outside corners of the floor to be protected. The curtains should be carefully lashed to the columns of the floor below, care being taken to have the canvas curtains extend from the exterior forms so as to provide a circulation of heat (See Fig. 2). Then a curtain hung across the width of the building under the forms will shut off the section to be concreted. Enough salamanders should be provided to maintain a temperature of from 60° to 80° in this section. This will usually require one salamander to every 300 ft. of floor area. The side curtains should be in place and fires started in the salamanders as soon as or before concreting is started and in extremely cold weather the curtains should be in place and fires burning for several hours before beginning to deposit concrete. As soon as one bay of the slab is concreted it should be immediately covered and in general the entire work should be closely followed with the protection.

Where the bays are not over 20 ft. square provide one heat hole about 8 by 12 in. through the slab so that circulation of heat may be maintained all over the slab. In larger bays, provide a heat-hole for about each 300 ft. of floor area. These heat-holes should have beveled sides so as to make the filling plug of concrete perfectly secure (See Fig. 2.) When the canvas is removed the heat-holes should be covered with boards.

It is the best practice in winter work to concrete the columns the same time as the floor and in this case great care should be taken to tamp the columns to prevent shrinkage cracks between slab and column head. Tamping sticks should be left in the head of the column and for several hours after the floor is concreted tamping of the columns should be continued. If the columns are concreted the day previous to the floor slab the side protection should be in place, floor forms made tight and the tops of the columns covered to prevent the concrete in the column heads from freezing.

One of the most difficult places to protect from frost is the base of exterior columns. It is frequently found that with a temperature of 50° near the under side of the slab a temperature below freezing will be found near the bases of the external columns. Hence, in extremely cold weather it is necessary to place a salamander on two sides of every external column. The bottoms of the columns may be further protected by packing the forms with marsh hay or other suitable material. When unusual speed is required or in extremely cold weather it will be necessary to curtain the floor below and place salamanders around the bases of external columns. By this means the bases of the finished columns will be supplied with heat. This method of protection is also necessary when monolithic walls are carried up with the building as it is practically impossible to protect them from the cold unless heat is supplied from the story below. If the walls are blank it will be necessary to provide openings in the forms to allow circulation of heat to the outside of exterior walls. These openings should be about 8 by 12 in. and should be beveled down and upward so as to prevent water from entering the building when holes are plugged. (See Fig. 3.) There should be two such heat openings in each panel between columns.

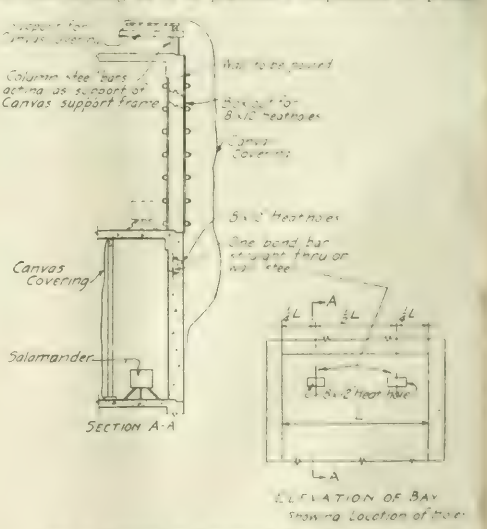

Support for Canvas covering
Hole to be poured
Column steel bars acting as support of Canvas support frame
Boxed out for 8x12 heatholes
Canvas Covering
8x12 Heatholes
One bend bar straight thru or ... steel
Canvas Covering
Salamander
SECTION A-A
A
A
8x12 heat hole
ELEVATION OF BAY Showing Location of Holes

Fig. 3.—Method of Protecting Exterior Columns.

It is important that the man tending the salamanders be carefully instructed as to the proper method of firing and as to the precautions necessary to prevent the canvas and forms from catching fire. Best results in firing will be accomplished if a small amount of fuel is applied frequently thus obtaining a maximum of heat with a minimum of smoke. The average laborer has a tendency to apply a large quantity of fuel at infrequent intervals as this tends to lighten his work.

As a protection against fire several buckets of water should always be standing on each floor when salamanders are burning. They should be inspected frequently to see that the water has not leaked out or frozen. Care must be used to see that the canvas is securely fastened in order to prevent it from blowing against the salamanders as experience has shown that this is the greatest fire hazard and source of danger from fire.

During the entire time that protection of concrete is in progress a detailed temperature record should be kept in permanent form showing the data and hour, outside temperature, temperature at bottom of columns, temperature at under side of the slab, under the canvas over the slab, and the temperature of the concrete as it is placed in the forms. Temperatures should be taken at the bottom of a number of exterior columns and especially those columns on the windward side of the building.

The superintendent in charge of winter construction work should make a personal inspection of the job before leaving at night in order to see that all the precautions are being carried out. He should also make occasional visits to the work in the course of the night in order to see that all the men are carrying out their various duties.

The following is the practice of the Turner Construction Co. in regard to the removal of forms: The top canvas shall not be removed before the end of the second day or before at least 48 hours after the concrete is in place. At this time the exterior columns may also be stripped. To do this, it will be necessary to loosen the side curtains for at least a short period, but the operation of stripping should be carried on as quickly as possible and the side curtains carefully replaced so as not to lose the heat from under the slab. The side curtains should not be removed before the end of 4 days or at least 96 hours after the concrete is in place. At this time the curtains may be stripped and on the following day the remainder of the forms may be taken off.

For flat construction the top canvas should not be removed before the end of the third day or before the concrete has been protected in place for at least 72 hours. The exterior columns may also be stripped at this time, taking care to replace the canvas as soon as possible. The side canvas should not be removed before the end of the fifth day or 120 hours after the concrete is in place and protected. At this time the floor forms may also be stripped.

Because of the speed at which multi-storied buildings are usually erected, the dead load of the story above is often added when the concrete of the lower story is from 7 to 14 days old and which has been protected from the cold only 5 days. We know that from the experiments described such concrete has only a fraction of its ultimate strength. This is particularly important in buildings of flat slab design where the upper part of the slab has to take compression. Therefore, the importance of having the upper part of the slab well hardened before any forms are removed is readily seen. In beam and girder construction this weakness is not so marked as three sides of each beam and girder are exposed to the heat and therefore probably gain strength more rapidly than the surface of the flat slab.

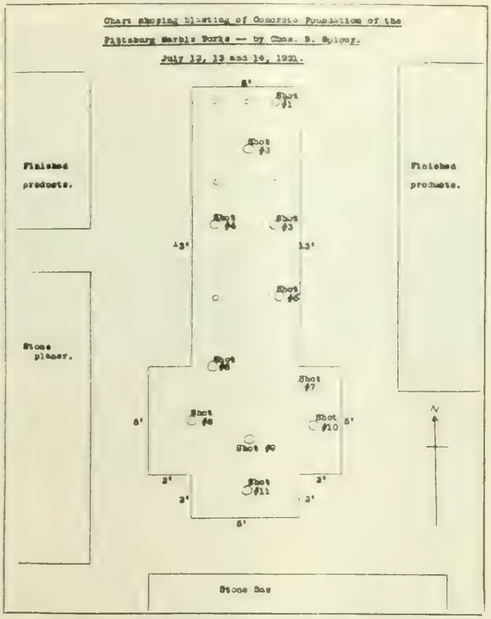
Percentage of Home Ownership in Cities of the United States.—The Division of Building and Housing of the Bureau of Standards has recently completed a chart showing graphically the percentage of home ownership in 1920 in cities of the United States having a population of over 100,000. This chart is based on statistics compiled by the Bureau of the Census and also includes a table giving the same values as the chart and in addition the percentage of ownership in the years 1910 and 1900. In 1920, the lowest percentage of ownership in the country was in New York City, having 1,278,341 homes of which 12.7 per cent were owned by the occupants. At the other end of the list is Des Moines, Ia., with 31,644 homes of which 51.1 per cent are owned.

Removing Concrete Foundations by Blasting

A concrete foundation for a [illegible] in the Pittsburg Marble Works, Pittsburg, Kan., [illegible] effectively and economically by the use of dynamite. The method of handling the work was described by Charles B. Spicer in The Hercules Mixer, from which the matter following is taken.

The concrete block was 4 ft. [illegible] ft. long and 5 ft. wide. One end of it was within [illegible] of some costly machinery. There also was a large stone planer about 10 ft. distant, and in addition there was a considerable amount of finished cut stone in the building.

Work was started at the end of the concrete farthest away from the machinery. Three holes were drilled at this end with the intention of making the first experimental shot at hole No. 1, which was placed 15 in. from the side and end of the concrete face, and was drilled about 2 ft. deep. The concrete foundation extended about 18 in. above the ground, the rest of its 4-ft. thickness lying below the surface. The original idea had been to bar down this concrete, and for this purpose a ditch a little less than 2 ft. deep had been dug all around the foundation.



Sketch Showing Location of Shots for Blasting Concrete Foundation.

On shot No. 1, ½ a stick of 40 per cent. Extra L. F., 1¼ in. by 8 in. was used. It was necessary to prevent small particles of concrete from flying, and it so happened that there was a considerable quantity of baled excelsior on hand, which was used for packing and shipping stone. Two bales of the excelsior were placed over this first shot. The charge was fired by a blasting machine, and even though only ½ a stick was used, it was readily apparent that this was more than necessary; the shot broke the end of the concrete along the line of the three holes drilled, although only one had been loaded.

The second shot was placed about 2½ ft. from the face which had been made by the first shot. As the burden on the second shot was heavier than on the preceding one, ½ a stick was placed in the hole, which was about in the center of the foundation. This time 6 bales of excelsior were placed over the shot, and it did fine work. Two other holes had been drilled ahead but not loaded. The shot kicked back and broke these holes. Accordingly the next two holes were loaded with [illegible] of a cartridge each. These holes were fired by a blasting machine with good results. Three holes close to the cross-arm, loaded with ⅓ of a cartridge apiece were then shot. Several bales of excelsior were placed over each shot in order to keep small particles from flying. The last hole fired, shown as No. 9 on the sketch, had only been drilled about 10 in. when the jack-hammer used for drilling broke. In this hole only 2 in. of 40 per cent were placed. The shot threw the bales up rather high and scattered the material a little, doubtless due to the fact that there was not sufficient burden to hold it back.

A total of 13 electric blasting caps and 5 cartridges of dynamite was used on the entire job. The amount of concrete removed was 240 cu. ft., and the total cost for explosives was $1.56.

It was learned from this work that baled excelsior is a good material to hold flying missiles. In places where excelsior is not available, baled hay or straw, which can be found readily, should prove satisfactory.

Twelve Technical Societies of Detroit Form Central Association

After several years of thought and discussion along similar lines, the movement for the affiliation of the architectural, engineering and other technical societies of Detroit was taken up seriously in June, 1921, by the organization of a temporary council composed of two delegates from each of the several societies interested. The affiliation has become an accomplished fact, taking effect Jan. 1, 1922, by the ratification of the proposed constitution and by-laws, acceptance of membership and election of councilors by the following twelve societies: Detroit Section, American Society of Civil Engineers; Detroit Chapter, American Association of Engineers; Michigan Chapter, American Society of Heating and Ventilating Engineers; Detroit Post, Society of American Military Engineers; Detroit Section, American Society of Mechanical Engineers; Detroit-Ann Arbor Section, American Institute of Electrical Engineers; American Institute of Chemical Engineers; Detroit Engineering Society; American Chemical Society and Detroit Chemists; Michigan Chapter, American Institute of Architects; Detroit Section, Michigan Society of Architects; Detroit Chapter, American Society of Steel Treating.

The permanent council met and organized Dec. 13, 1921, and elected officers for 1922 as follows: Chairman, P. W. Keating; vice-chairman, A. A. Meyer; secretary-treasurer, Walter R. Meier.

The engineers, architects, chemists and other technical men of Detroit have for some time appreciated the need of one central association to represent the combined interests of these professional men. A central office will be established for conducting the business of the several societies. In the past, the several societies each held a number of meetings throughout the year. Most of the societies met regularly once a month and some of them two and three times a month. In the past, the meetings of the various societies have often occurred on the same date. This conflict of dates will hereafter be avoided as the office of the new association will schedule the dates of meetings of all the technical societies. The Associated Technical Societies of Detroit will provide one meeting each month and this meeting will be under the management of one of the member societies. This member society will provide the speaker on a broad subject of interest to the members of all the technical societies.

The paramount use of the new association to its members and to the public is its opportunity for public service both for the city of Detroit and for the state of Michigan. The association will take an active interest in all matters wherein engineering, architectural and technical subjects are an important factor. The council will study the opinions of the membership and will assist in furnishing definite and accurate information to the public. The association will offer its assistance and service to city and state officials whenever requested. The aim and purpose of these activities will be to provide the highest and most reliable technical information for the proper consideration of public improvements and public undertakings in which all our citizens are interested.

A Review of Iron and Steel Prices and Production in 1921

Those who have wondered at the price movements of iron and steel products during the past 15 months will find in the opening article of the Jan. 5 issue of "The Iron Age" an interesting account of some of the circumstances and influences by which prices and production were most affected. We quote in part.

> The one thing in the record of 1921 as a steel year that stands out above all else, and that was continually a marvel, was the way in which consumers got steel without going to the mills. There was much more steel in the country, in the hands of jobbers and manufacturing consumers [illegible] than had been thought. The country never got going better than a 38 per cent operation of its steel capacity and it would not have done so last year but for using up to the last ton what was carried over from 1920. Thus the effort of consumers in all lines to reduce their steel inventory to the lowest point dominated market operations. As prices steadily declined resort was had to every expedient to avoid drawing on the mills for fresh supplies. Railroads shipped steel across the country from one repair shop that had fat stocks to another that had little. Jobbers in iron and steel traded with competing jobbers, swapping sizes and items in which they were overstocked in exchange for sizes and items of which they had little. Steel companies at times shipped from their warehouses at mill stocks rather than start up a mill for a meager rolling on which delivery was due.
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> Blast furnace yards were full of ore bought at the high prices of 1920. Throughout the year such stocks were a heavier and heavier incubus on the ore and pig iron markets. As illustrating the inclination of the whole trade, particularly in the early months of the year, to take the most hopeful view possible of the future, the estimate was common at the end of March, and it appears in our market summary of March 31, that "less than 40,000,000 tons of Lake Superior ore will be shipped this season," seeing that fully 41,000,000 tons were then in furnace yards and on docks. "Less than 40,000,000 tons" was quite correct. But there was no idea on March 31 that the season's movement down the lakes would turn out to be so little as 22,300,000 tons.
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> **Consumers Turn Jobbers.** An unprecedented thing was added to all the other influences at work to restrict demand for steel. Along in the second quarter of the year large manufacturing consumers turned jobbers, selling off bars, plates, structural shapes, or whatever they had on hand, at less than warehouse prices. Many of the Steel Corporation's contracts in 1920, taken at much below prevailing prices, were written down as firm orders and the buyers took the deliveries when due. In some cases they could not use the steel, but generally the reselling was prompted by the belief that it could be replaced later at lower prices.
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> **Steel Corporation and "Independent" Prices.** The low prices maintained by the Steel Corporation in 1919 and 1920, ranging from $10 to $30 per ton below those of independent steel companies in different products, extended their influence into 1921, but not for long. The year opened with the Steel Corporation operating at 85 to 90 per cent of capacity. Independent companies . . . early in January ran at less than half the Steel Corporation rate. Later in that month independent mills operated at but 20 to 30 per cent of capacity. . .
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> . . .
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> At the beginning of the year the Steel Corporation was still adhering to the so-called Industrial Board prices of March 21, 1919. But only a few weeks had passed before the independents went lower . . . Cuts of $5 per ton below the Steel Corporation schedules came promptly, the products chiefly affected being plates, shapes and bars. The decline went on for several weeks, the Steel Corporation meanwhile maintaining the prices to which it had adhered for about two years.
>
> . On April 12 the Steel Corporation announced that it had decided to make substantial reductions, putting bars at 2.10c. and plates and shapes at 2.20c. At the same time independent companies, which had been selling below these prices, advanced their quotations to those announced by the Steel Corporation. It was apparent in May that these prices were not holding, some plate mills having made a 2.00c. price, and some bars were sold at 1.90c., Pittsburgh. These price cuts did not increase the volume of business, there being no evidence of a stimulating influence.
>
> On July 5 the Bethlehem Steel Co. announced reductions amounting to $4 per ton on bars, plates, shapes, billets, skelp, sheet bars and blue annealed sheets, $5 for black and galvanized sheets and $10 for tin plate. On some products this announcement merely recorded what the market already had done.
>
> Through the remainder of the year prices kept on declining. One small counter current was started by an advance of $2 to $3 per ton in wire products made by the Steel Corporation, effective Sept. 16. The real effect of this advance was to bring a large amount of business on its books at prices previously prevailing,

which were $2.75 per keg for wire nails and [illegible] per 100 lb. for plain wire.

. . .

Uneconomical Operation. Throughout the year steel companies were constantly at work to get costs down. Generally wages were reduced. But economies in operation were effected such as were not possible in the strain for output which [illegible] most of the months of 1920. Crews were recast. Fuel economy was studied anew, in view of the war wages paid at coal mines and the high freight on coal. New economies were found in the use of refractories, lubricants and all other supplies, whose costs had run up beyond all precedent. Per capita output was increased in some classes of operations. At blast furnaces accumulated flue-dust piles were made available by sintering, resulting in some cases in considerable percentages of high priced ore in blast furnace mixtures.

But every effort at economy, even that secured by the easiest and least desirable route of wage cuts, met very [illegible] at the hands of High Unit Overhead. All that steel producers had learned of the incomparable value of large tonnages as a [illegible] into fixed charges had to be forgotten. Small runs, spasmodic starting and stopping of mills, and at all times fractional operation of producing capacity were inseparably baffling. Cases are known in which, rather than start up a mill to make a scheduled delivery, the producer bought the material from a competing company. The latter got the benefit of a longer run, which helped its cost, while steel company No. 1 was able to buy at less than it would have cost it to start its mill.

Sources of Demand. The railroads are credited with consuming each year a large percentage of the country's steel output. They did not consume much last year, but it is to be said in passing that the railroad consumption of steel is always exaggerated in the general thinking. It is doubtful if it has gone above 25 per cent in any year in the past 20, apart, possibly, from 1906 and 1907, and commonly it is not above 20 per cent. Throughout the year it was the constant comment in market reports that in the heavy products—rails, plates, shapes and bars—demand was indifferent. The lighter products did better: wire, sheets and tin plates. On the whole, there was a good business, particularly in the second half, in wrought pipe. The new oil fields of Texas and the revival in the petroleum market after a period of flatness brought out some good contracts for line pipe.

What saved the day for plate mills, in the small demand from shipyards and car works, was the unusual amount of tank work called for by the oil fields, particularly the Mexia field of Texas. In the second half of the year tank works in the West and Middle West were unusually busy on this account.

New construction, commonly called an index of activity in steel, was held back by excessive labor cost. There was a good deal more house building throughout the country than was commonly credited. This is established by the fact that foundries making heating furnace castings ran at a much better rate than others and that radiator companies really had a good year. Manufacturers of sanitary equipment and builders' hardware fared well also. A good deal was done in the erection of school houses and other public buildings, but not much in business structures, and very little in bridges. The bookings of the fabricating companies averaged for the year about one-third of their capacity.

Agricultural implement warehouses were pretty well stocked with machinery throughout the year, and manufacturers in those lines did little. No large buying of steel from that quarter is to be looked for until the farmer gets on his feet, and that will not be until after the next harvest. The automobile demand was about what it was expected of it—considerably less than half that of 1920.

Replenishment demand, after months in which the country had been swept bare of steel in all forms, caused the larger operation of steel works and rolling mills that dates from the early fall of last year.

Meager Demand from Railroads.—Railroad buying in 1921 was most disappointing.

Out of all the expectations of railroad buying entertained at the opening of the year the actual outcome was far below that of 1920. And 1920 was a year in which the railroads, directly and indirectly, consumed not more than 15 per cent of the country's steel output. New cars ordered were only a fraction of the 81,000 placed in 1920, being only about 20,000, and locomotives ordered for domestic use were fewer than 250. The repair of [illegible] cars helped in a measure to make up to the mills what they missed in steel for new cars. . . .

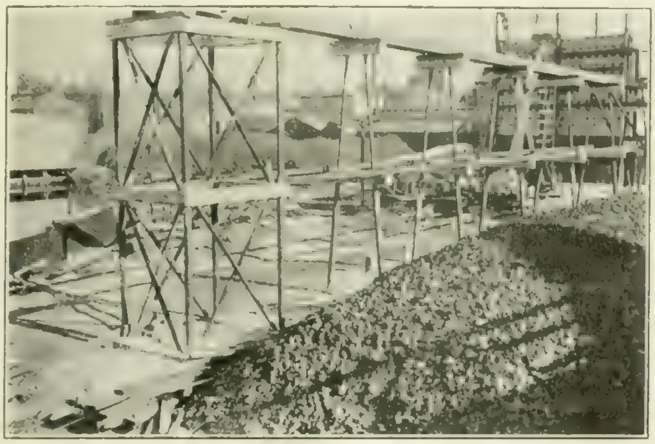
. . . . . .

Profits Disappear.—The year was disastrous for producers of iron and steel in all lines. A statement submitted at Chicago in December at the hearing on Lake Superior iron ore rates before an examiner of the Interstate Commerce Commission, made the ollowing showing of deficits in the first three quarters of the year: epublic Iron & Steel Co., $2,177,472; Lackawanna Steel Co., $2,-[illegible]; Midvale Steel & Ordnance Co., $3,933,731. The United tates Steel Corporation showed net earnings of $32,286,722 in he first quarter, against $42,089,019 in the first quarter of 1920; 21,892,016 in the second quarter, against $43,[illegible] in 1920, and 18,918,058 in the third quarter, against $48,051,540. The corporation paid its preferred and common dividends for all three quarters. After such payments it had a surplus of $2,816,905 in the first quarter and deficits of $1,[illegible] and $[illegible] in the next two quarters. The more favorable showing for the Steel Corporation than for independent companies may be explained in part in the light of the $95,000,000 fund it set aside from surplus "to absorb any sudden and violent diminution in inventory valuations." Charges and allowances for depreciation have been constantly less than in times of good earnings.

Unusual Trestle Construction

By J. B. HOLDCROFT.

The illustration shows an unusual and economical type of construction evolved during the course of extensions to the plant of the Victoria (B. C.) Gas Co., which has lately added two units of the West vertical continuous fired retorts to its plant. The trestle is intended to support an automatic gravity incline in connection with the system of coal storage adopted—that of the open stock-pile—and is over a reinforced concrete tunnel having gates at intervals in the roof discharging on to a belt conveyor which in turn delivers the coal to an elevator discharging at the retorts, shown in the background.



Trestle Constructed of Gas Pipes Filled with Concrete.

The interesting feature about the trestle is the material used in its construction, which for the uprights and diagonal bracing consists entirely of 4 in. and 6 in. cast iron gas pipes filled with concrete. No other reinforcement was used, except in the horizontal members which are ordinary reinforced concrete beams with twisted square bar reinforcement.

The structure is designed for stresses in compression only, and the iron members are not bonded together by wire or bolts, but are simply embedded in the concrete. The structure was designed and built by Mr. K. M. Chadwick, engineer of construction to the Victoria Gas Co., who was asked to use this material if possible, as a great deal of unused pipe was in stock and it was desired to keep down the cost of the additions to the plant as much as possible.

Corrosion of Steels.—Laboratory work relating to the determination of the relative resistance of certain alloy steels to corrosion when submitted to combined weathering and immersion in distilled water was completed during December by the U. S. Bureau of Standards. Based on exposure of 19 days, the polished samples of steel showed the best resistance to corrosion in the order given below:

(1) Annealed stainless steel (C 0.15 per cent, Cr 13 per cent).
(2) Annealed high chromium and high nickel steels.
(3) Forged stainless steel.
(4) Cast iron chromium alloy (C 0.04 per cent, Cr 6.5 per cent).
(5) Annealed Chromium steel (C .28 per cent Cr 8.6 per cent).
(6) Annealed chromium steel (C .30 per cent, Cr 5.72 per cent).
(7) Annealed chromium steel (C .28 per cent, Cr 3.90 per cent).
(8) Pure iron.
(9) Iron carbon alloy (C 0.45 per cent).

Building Codes*

By R. FLEMING

Historical.—The first building regulation of any American city, an "Ordinance of the Director and Council of New Netherland regulating Buildings in the City of New Amsterdam passed 25 July 1647," begins:

> Whereas we see and remark the [illegible] heretofore and still daily observed in building and erecting houses, in extending lots far beyond the survey lines, in setting up Hog Pens and Privies on the highways and streets, in neglecting and putting off to build on granted plots, the Honorable Director General, Petrus Stuyvesant, and the Worthy Council in order to prevent the same in future have Resolved to appoint three surveyors to wit:

We infer from this preamble that private trespassing upon public property was not unknown 275 years ago in what is now New York.

The building laws of 26 cities were analyzed and compared in a series of articles, "Comparative Municipal Building Laws," published in the "American Architect" during the years 1891-2-3. Whatever the faults of present codes may be, one need only compare them with those of 30 years ago to be convinced of decided improvement. The codes of 40 or 50 cities are now being revised and the antiquated codes of many others will soon have to be rewritten. In fact, all building codes are subject to constant revision as new conditions arise and new materials come into being. The Philadelphia "Regulations of the Bureau of Building Inspection in regard to Hollow Tile Building Blocks in Exterior Walls of Buildings" date only 3 or 4 years back. The use of reinforced concrete necessitated an addition to all codes. But a few years ago a roof was simply a roof and nothing more. The electric sign has changed this. In New York City alone hundreds of thousands of dollars are paid annually for the rental of roofs and blue sky. Hence the regulations regarding sky-signs found in recent codes. Owing to new subjects for regulation springing up, the book of building laws for many cities is becoming more and more bulky. That of Dayton has 336 pages, District of Columbia 312, Minneapolis 311, New York 320, Boston 551, Cincinnati 251, Chicago 240, Philadelphia 278.

The Building Code and the Structural Engineer.—The importance of the building code to the structural engineer is obvious from the fact that outside of mill buildings the great majority of buildings requiring steel in their construction are designed in accordance with a prescribed building code. The engineer is not at liberty to use his own judgment. Floor loads, wind pressure, unit stresses, thickness of walls, permissible heights, are given in the code. If requirements are unduly rigid they hamper building construction and retard the growth of the city. For instance, provisions regarding structural steel may be so exacting as to put a premium upon non-fire-resistive buildings. When carried out such provisions waste money for the owner and do not benefit the city. On the other hand requirements loosely or carelessly drawn result in defective construction—a source of danger to the community. Extended fires have occurred owing to a lack of fire walls, buildings have collapsed on account of weak columns and panics with loss of life have sprung from insufficient exits. In most cities a committee could profitably be appointed for the purpose of revising the building code by omitting all unnecessary requirements, modifying those that are needlessly severe and making such additions as time and experience have shown to be necessary. The 1920 census shows surprising increase in population over the 1910 census. Akron, Ohio, jumped from 69,000 to 208,000; Bethlehem, Pa., from 12,000 to over 50,000, and scores of small towns have become cities, all of which emphasize bringing the local building code to fit new conditions.

The Ideal Building Code.—Probably the first essential of an ideal building code is clearness. No clauses requiring explanation of their meaning should be used. Clearness includes accuracy, simplicity and definiteness. There should be no misunderstanding as to what is meant by the "height of a building." What is a "curtain" wall? The exterior walls of high buildings supported by steel beams at each floor are in present codes variously called "curtain" walls, "enclosure" walls, "filler" walls and "panel" walls. A code should be written in language simple enough for a non-technical man to understand. Requirements should be definite.

Another requisite is completeness. More than a score of codes give floor loads but fail to specify unit stresses. A reduction of the live floor load for columns of high office buildings and hotels is permissible but several codes are silent on the subject.

A paragraph or two in the code covering a subject is better than referring it to the building inspector. As a general rule questions likely to arise should be answered by the code rather than by an official of the building department. This tends to consistent practice for public officials are constantly being changed.

Fairness is a prime requisite in building laws as in all documents involving human relationships. A modern business building calls forth the work of many industries and the favoring of one interest at the expense of another is an imposition on the public.

A building code need not be a textbook. It presupposes trained architects and engineers who know how to do their work. For instance, the wind pressure and allowable unit stresses should be given but it is not the province of the code to prescribe the method of obtaining the stresses. The words "proper provision" have been worked overtime, but, "Proper provision must be made for eccentricity," is about all that a code can say on this subject. What this provision shall be must be obtained from experience and text books. The code of South Bend, Ind., gives a formula to be used but it is correct only for certain cases. The rules of the building code "cannot produce or supersede judgment; on the contrary, judgment should control the interpretation and application of rules."

What provision shall be made for the greater city of the future? Trenton in 1890 had a population of 57,000, in 1900 of 73,000, in 1910 of 97,000, in 1920 of 119,000. That is, it has increased 25 per cent in the past 10 years and doubled in 30 years. Maintaining the past rate of increase it will be in 1950 a city of more than 200,000 inhabitants. To what extent should the building code anticipate this growth? Take for one instance the limiting of building heights, the storm center of the subject being the fireproof commercial building. The factors entering into a consideration of the subject are too many for discussion here. In 1910 only a dozen cities restricted the height of fireproof commercial buildings, today the number has increased to 60 or more. Had New York and other large cities taken hold of the subject 30 years ago the situation would be far different than what it is at present. The obvious lesson for the smaller city is to ordain from the start the control that will probably be needed in its future growth. The State Building Code of Wisconsin will be quoted: "This code sets no limit to the height of a fireproof building, as it is felt that this is a matter of general community welfare rather than the safety of the individual occupants. The Industrial Commission strongly recommends that each municipality adopt such a limit, before the rise in central land values makes such action a hardship to the property owner."

City Zoning.—A burning question today in all large cities and in many smaller ones is that of zoning or districting. Much is being written on the subject. The old idea that within his lot lines a man owned as far down as he could dig and as far up as he could build and that he could build within these lines what he pleased, is being outgrown. His neighbors and the community have an interest in the use to which he puts his property. Sixty-seven cities in the United States are reported to have some kind of zoning regulations now effective, and twelve cities have complete, comprehensive zoning ordinances limiting the use of property, height of buildings, and area of lot that may be covered in every city block within the city limits. A group of vacant lots in a residential district is always a menace as they may be purchased for almost any purpose. A high apartment house may be built out to the street line with windows on either or both sides opening on private grounds. A $25,000 garage may cause a depreciation of $100,000 in neighboring property. A factory may practically ruin acres of property around it. We have all seen properties depreciate and neighborhoods deteriorate from just such causes. Zoning is the putting of the right building or set of buildings in the right place. It is too large a subject for a few minutes talk. To be effective and not work injustice zoning ordinances should only be passed after careful study and much thought.

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*[illegible] a paper read [illegible] before the Engineers' Club of Trenton, N. J.

Why Present Cost of Building Operations May Not Reach Lower Level

Facts tending to show that the present cost of building operations is either reaching or has reached, about the lowest point it will reach for the next few years were given by Mr. Morton C. Tuttle, General Manager, The Aberthaw Construction Co., in an article in the Nov. 25 issue of The Boston Transcript. We are quoting from the article as follows:

Wages in Building Trades.—The statement is commonly made that building operations will not be possible until labor has been liquidated; that is, until wages reach some theoretically proper point below their present level. This statement needs analysis. The union rates of the city trades are the ones usually considered in discussions regarding labor liquidation. It is forgotten that only a fraction of the building business of the country is done in the big cities, that normally millions of dollars are spent on railroad rights of way, on dam construction, on highway work, on small dwelling house work, in industrial and country districts where the wage rate is, and always has been, lower than in the metropolitan districts. Disregarding this fact, however, and taking the Boston wages for example, the following facts must be weighed.

The Massachusetts retail index of items entering into the cost of living, rose in July, 1920, to 202.6. By June of this year it had dropped to 159.4, beyond which it did not drop, but rose a little and then moved horizontally—this based on a scale of 100 in 1914 and 1915. That is, the average householder in Massachusetts paid in October of this year $1.60 for the same items of living expense for which he paid $1.00 in 1914 and 1915. In 1914 a carpenter received 50 ct. an hour; in 1915, 55 ct.; in 1916, 58 ct. In order to retain the same purchasing power on the same number of hours of work based on a 1915 55-ct. wage, he would receive 88 ct. an hour today. The present Boston rate for carpenters is 90 ct. an hour.

Masons received 65 ct. an hour in 1914 and 1915. To retain their same purchasing power they should now receive $1.04. The present rate is theoretically 90 ct. Practically the rate for masons is running a little above $1.00 per hour.

Laborers throughout New England were hired in 1914 freely at 25 ct. an hour. The same rate held for 1915 and 1916. A compensating rate for the present time, accordingly, would be 40 ct. an hour. Good laborers are being hired today at between 35 ct. and 40 ct. an hour. Between 1914 and 1921 labor not only gained an increase in rates but earned also a great deal of overtime during the war rush. This was commonly paid in double-time rates over eight hours. This overtime increment has been lost. Today it is conservative to say that the purchasing power of skilled and unskilled building trade labor is less than in 1915 and 1916. It is fair to add that labor has itself been responsible for decreasing its annual income by the insistence upon Saturday holidays and the limitation of its daily hours of labor.

Greater Output from Labor.—Unless one believes that the cost of living is to decrease rapidly, or that labor will consent to work longer hours, it must be concluded either that a large class of our citizens are peaceably to accept a cut in their long-established standards of living, or else we must decide that drastic cuts in wage rates are not probable. This last idea is strengthened by the realization that building-trades labor is far better organized than it has been before, and that there is a considerable decrease in the proportion of men available for certain of the skilled trades. In the past five years very few plasterers, brick-layers, tile setters or marble workers have been trained because these trades were inactive during the war period.

While we are considering labor, it is well to remember one interesting fact; namely, that during periods of depression when jobs are scarce, employers are able to select the most skillful men in all trades, and the most active laborers. These men at the same time are increasingly interested in holding their jobs and are not slowed down by being obliged to work side by side with less skilled men paid the same rate per hour. As a result, in times of depression building trade labor, skilled and unskilled, delivers about 20 per cent more output per hour than during periods of building activity. The records of my own company indicate that we are averaging man per man 20 per cent more output than we obtained during 1919 and the early part of 1920. This, as I pointed out, is the result not alone of speeding up, but of the selective process plus a closer supervision. It is unmistakably clear that the 20 per cent improvement in output will be lost as soon as the building business picks up enough so that jobs become plentiful and the selection of men becomes limited. The importance of the 20 per cent saving on the labor items of a building job becomes clear when it is understood that in the cost of an ordinary mill building between 40 per cent and 50 per cent of the total cost of the job is in direct payrolls. Twenty per cent saving of 40 per cent makes a total saving of 8 per cent on the total cost of such a structure from this one item alone.

It is further to be understood that about one-half the amount of the payrolls goes to unskilled labor in an average building operation. Accordingly, wage rates of common labor and its efficiency are as important as the questions of rate and efficiency for plumbers, steamfitters, bricklayers, carpenters and the skilled trades. Even the believers in future wage reductions do not suggest that common labor will be called on for much deeper cuts than it has already received. On the whole, the probability of making future sweeping economies on the labor side of building operations appears less promising than it did at first glance.

Prices of Materials.—Turning to the cost of materials entering into building construction, taking 1914 as 100, the price of structural steel, the great war necessity, rose, in 1917, to 400. This was promptly taken under control by the government, with the result that in 1918 it had dropped to 260. It rose again during 1919 to 330 and since that time has declined to about 145. Spruce lumber, brick, cement, hard pine, glass, all rose by various stages to a peak of about 280 in 1920, since when they have all tobogganed to between 140 and 190. The United States Department of Labor wholesale commodity index during this period rose to about 272 and has dropped at the present time until it reached 148 in July of last year, and since has risen a point or two.

There is an increasingly substantial belief that the general commodity index is likely in the period of the next two or three years to rise rather than to fall. Assuming that it remains stationary, or even drops slightly, it is hard to reason that the price of building materials will in general drop much further. Certain items may drop a little, but unless there is a general decline in all commodities it is reasonable to assume that building material will follow the general trend of other prices.

The cost of industrial buildings rose to a peak of about 260 in July, 1920, and has since declined until it stands at the present time at about 157. Again, unless the assumption is made that the general commodity prices are to decline markedly, there is nothing in this figure that indicates a large margin for drop in costs.

Relation Between Rents and Building Costs.—No one has failed to observe the large number of building operations now going on. There are among these operations not only the public and semi-public buildings, such as churches, school houses and municipal buildings of one sort and another, but more conspicuous than all of them is the large number of housing operations. The reason for this becomes clear when it is understood that in August of this year rents had risen and the cost of buildings had dropped until the relation of rents and buildings costs was re-established on the 1915 ratio. Assuming that there was a proper relationship between rents and building costs in 1915, then the same condition had been re-established in August of this year, and there should be a fair return for investment in real estate. The re-establishment of this relation has apparently resulted in the large amount of home building for ownership and for rent, and it is reasonable to expect an active resumption of speculative building if rents remain at their present levels and building costs stay where they now are.

It is perilous at any time to reason that because a commodity is theoretically cheap it will be bought. The past two years have proven that the buyer has a great deal to say about costs, at least over a short period. It is obvious that building costs, like all other costs, have taken a tremendous drop from their peak, that they have reached at the present time about the general level of commodity prices, that in order to further reduce building costs it will either be necessary for the men to accept longer hours or else necessary for them to take a sharp decline in their living standards. Dependent upon one's belief as to whether either of these courses is likely, will be that individual's conclusion as to whether building costs are going much lower than at present. It does not appear that building labor is profiteering so far as rate of wages is concerned.

It seems reasonable to predict that any drop in wages and prices of material sufficient to stimulate building activity will be promptly followed by a loss in efficiency of labor and a rise in the prices of material that will make today's costs look low. It is hardly probable that the next two years will show as favorable building costs as can be obtained in the next few months.

The Choice Between Steel and Concrete for Tunkhannock Viaduct*

By GEORGE J. RAY,

Chief Engineer, Delaware, Lackawanna and Western Railroad

In order to construct the line with the established grades it was found necessary to cross the Tunkhannock Creek at an elevation of approximately 240 ft. above the water, which would require a structure from 2,500 to 3,000 ft. in length. After spending much time in arriving at what we considered the most economical design for a concrete viaduct, we submitted the plans and specifications to contractors for bids. At the same time we asked 5 or 6 bridge companies to submit bids on a steel structure. The bridge companies were all requested to submit bids both on the design made by the railroad and on their own design, thus giving each bridge company an opportunity to work out the most economical design for a steel structure.

Initial Cost with Sinking Funds.—When the bids were received it was found that the first cost of a steel viaduct consisting of an 8-in reinforced concrete floor slab supported on transverse "I" beams which in turn were supported by three lines of deck and two lines of through plate girders carried on towers, was slightly over a million dollars. We estimated that a $200,000 sinking fund at 4 per cent interest was necessary to paint, inspect and otherwise maintain the steel viaduct. We assumed that 50 years would be the maximum life of a steel viaduct and that a sinking fund of approximately $150,000 would be required to replace the structure in fifty years provided that the viaduct could be rebuilt as cheaply at that time. The total cost of the steel viaduct, therefore, on the 50-year life basis amounted to approximately $1,350,000. Our estimate for the concrete structure based upon the figures received from contractors, was $1,349,000. The actual cost of the concrete viaduct, including all extras, waterproofing, etc., was $1,424,950.

Safety from Accident. Several points in favor of the concrete viaduct caused us to adopt it in preference to steel. The points I refer to may be summarized as follows:

1. With any future increase in live load up to 50 per cent over the loads of 1912 the unit stresses will not be increased over 10 per cent.

2. The concrete structure as designed and built is a more substantial structure and less liable to be damaged by derailment or a wreck of any kind. In the case of an engine or car falling over the side of the structure no damage whatever could possibly be done to the concrete viaduct, whereas a steel viaduct might be very seriously injured and traffic tied up for an indefinite time. Steel structures of much less height have been put out of service for weeks on account of a tower post being knocked down by a derailed car. With the concrete viaduct, there is little possibility of a derailed car or engine ever falling over the side of the structure. A very substantial retaining wall was provided on both sides and will act as a guard in case of derailment. Such a guard could not be provided on a steel structure without a very large increase in the cost.

3. It would be impracticable to rebuild the steel structure in the future on the original foundations when necessary to replace. This would require a change in line with increased cost for rock excavation and embankment.

Stabilizing Private Industry Through Public Works*

By OTTO T. MALLORY,

Member of President's Conference on Unemployment.

The business world has long regarded industrial depression as an extraordinary accident—a suddent stroke of paralysis for which there is no remedy except patience and hope. Another conception is revealed by a study of the last hundred years of industrial history of the United States. These apparent extraordinary accidents are seen to be events recurring with some regularity every seven to ten years. After a depression there is a gradual rise, becoming more rapid as the crest of the wave is reached. At the crest there is a scramble for labor and materials, prices and wages soar, and credit is over-strained. When the wave breaks, the higher the wave the greater and the longer and the more severe the subsquent depression and unemployment.

These periods of depression seem to be speeding up in accordance with the acceleration of modern life. They occur more frequently than 50 years ago. Once upon a time laws were passed prohibiting railroad trains from running more than 5 miles an hour through a town. Now if a motorist travels through the city at less than 15 miles he may be arrested for obstructing the traffic. As depressions are getting more frequent and more acute, methods must be found for preventing or mitigating them else our complex business structure cannot survive.

Two important methods are proposed by competent business men and engineers. The first is the outgrowth of the study of waste in industry conducted by the Federated Societies of American Engineers under the leadership of Mr. Hoover. These studies point out certain practical steps in the elimination of waste and have led to further study of the specific industries, now being conducted under Mr. Hoover's direction.

The second method is a recommendation of the President's Conference on Unemployment, embodied in Senator Kenyon's bill, favorably reported to the Senate in December. This bill, S-2794, provides that public works be postponed when private industry is competing for the same men and materials and the accumulation executed during periods of industrial depression. Everyone admits this to be a wise plan. The only question is how to accomplish it and how large will be the results.

What the Kenyon Bill Proposes.—The Kenyon bill is no panacea, but provides for a few of the first steps. The Federal Government's chief public works are rivers and harbors, public buildings, reclamation, and federal aid to roads. The Kenyon bill proposes that advance engineering plans for all such work be kept ready so that an appropriation by Congress at any time would result in immediate execution during a period of depression. On the other hand, the Federal Government proposes not to execute any postponable public work during boom times and thus refrain to that extent from raising the height of the wave of business activity. It is the last straw that breaks the camel's back. In a boom it is the last few hundreds of millions of dollars of orders concentrated into a short period that sky-rocket prices, shake credits, and bring down the structure with a crash.

Federal public works from taxation plus municipal and state public works, as measured by bond issues alone, averaged in 1919 and 1920 $725,000,000 a year. If a substantial portion of this amount can be held back during years of active industry, the strain will be relieved to that extent. A governor for an industrial engine will have been invented which will steady employment in good times and bad. The Kenyon bill aims to do this as far as federal public works are concerned, but those are only one fifth the total public works done within the boundaries of the United States. Public works of cities are more important because they are so much larger in volume. How can the cities help? A city plan looking ahead ten years and anticipating the probable growth and needs of the city will be helpful in carrying out this policy. When prices are low and labor plentiful, the major features of the plan can be undertaken. During the years of active industry only those projects urgently necessary need be begun.

Trend of Business Reports to Serve As Guide.—How can the Federal Government or the cities know the best years to expand public works? By our system of crop reports the business world knows the probable yield of wheat or corn long before it is harvested. By the Kenyon bill a similar report indicating the trend of business will be inaugurated by the Department of Commerce. Specific and general business conditions will be compared month to month in more complete studies and analysis than have heretofore been attempted. These reports would serve as a guide to the Federal Government. When the wave of private industry is rapidly rising, federal public works would be postponed. When serious unemployment is in sight, at a given signal all accumulated federal public works would go forward. The cities may be expected to make use of this guide and thus make a national synchonous policy possible. Any city which follows such a course will build less of its 10-year total at top prices and at the same time steady employment at home.

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*[illegible] paper on the economics of the [illegible] read before the Western Society of Engineers Dec. 15, 1921. The greater part of the paper was published in Engineering and Contracting [illegible]

*From an address presented Jan. 18 at annual convention of the Associated General Contractors of America.

Business men may well make profitable use of this survey of business conditions and thus avoid contracting credits which freeze on their hands, and postpone plant extension and large purchases when the wave is near its top. Some large corporations already have their own experts to chart those movements, and as a result a number of them came upon the present depression fully prepared. The profits they earned by being able to buy freely after the drop and to manufacture while their competitors were overstocked at high prices, were profits well earned. Each one of those corporations did its share in diminishing the depression because it had checked its own expansion during the rise. At school we learned that little drops of water, little grains of sand, make the mighty ocean and the mighty land. Every little industrial plant and every little town can add a grain to the stability and safety of the whole mighty country.

How Public Works Can Take Up Slack in Factory Production.—A few figures are encouraging. The national income, measured by production, averages forty billion dollars. The widest fluctuation in factory production is decreased by two billions. If 20 per cent of all public works are postponed during good years and executed in one year of depression which may come once in ten years, public works can lift one-half the weight of a serious depression in factory production. After making allowance for all variations in production, such as mining, transportation, it is estimated that public works can be arranged to make up one-third the total of variation. In reality it can do more; it can lengthen the intervals between depressions by diminishing the height the wave is allowed to reach at any time. Such a program vitally affects the construction industry. When fully carried out a contractor will be assured that when private contracts are scarce public contracts will be more plentiful.

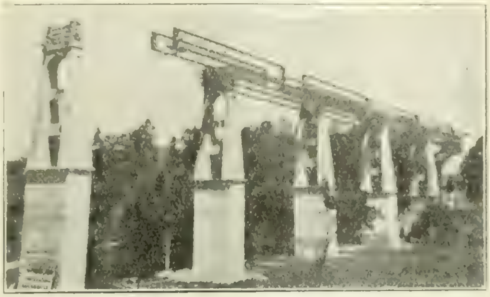
Proofs of Practicability of Program.—In 1921, when private industry was employing a lower percentage of men than ever before, as far as we can judge from available statistics, public works were employing twice as many men. The war has checked public works in the same way that the Kenyon bill proposes to do during peace times of active industry. Consequently, part of the accumulation was ready to hand. The municipalities prepared to do $600,000,000 more of public work than ever before, a total of $1,200,000,000 during a year when private corporations were making a minimum of expenditure for new enterprises.

The other proof is equally striking. Heretofore the bulk of road construction has been concentrated into a few summer months. Preparations were made slowly during the spring. Now for the first time manufacture of tractors and road machinery report that they received orders in December which formerly did not come to them until April. Consequently, work will be fully under way on the roads several months earlier in 1922 than heretofore. This is clearly a result of the kind of advance planning recommended by the President's conference on unemployment. In Minnesota, New York and elsewhere, the road materials are being placed on the ground during the winter, thus giving employment during more months of the year and at a time when the contractor's men and teams would otherwise be idle.

We can look back on 1921 as a year of great depression and also of great promise. The conference on unemployment and the Kenyon bill have stated a new national policy of preparedness in industry. In these great efforts at a new industrial statesmanship Mr. Hoover's hand, often invisible, is even at work.

Pilot Method of Erecting Steel Girders for Canadian Bridge

An interesting method of erecting the steel girders was employed at the Sixteen Mile Creek bridge on the Dundas Road between Toronto and Hamilton, Ont., one of the largest structures that has been constructed on the Ontario provincial highway system. This bridge is 993 ft. long, comprising 8 spans of 108 ft. 6 in. each and two flanking spans. From deck to water level the height is 118 ft. The substructure comprises concrete abutments and piers, while the superstructure consists of concrete beams and deck carried on deck latticed trusses of 108 ft. 6 in. span and spaced 13 ft. 6 in. center to center. The width is 20 ft. from inside to inside of hand rails, giving a clear roadway width, allowing for curbs of 19 ft. It was designed for Class "C" loading of the Ontario Department of Highways (20 ton concentrated load). The following notes on the construction methods are taken from The Contract Record:



Erecting the Girders Without Falsework.

The construction of the bridge was largely a mechanical job, with the labor force kept to small dimensions. While the contractors' camp provided for fifty men, there were never that many on the pay roll. The chief part of the construction plant was a Florry 5-ton steel cableway, 1,200 ft. long, on wooden towers, 100 ft. high. Practically all operations in connection with the bridge including excavation, form handling, concrete pouring and erection of girders, were carried out by means of this cableway. It was operated from the west bank, at which point was also located the mixer plant, comprising a steam driven 1-yd. mixer, fed from overhead bins through measuring hoppers and discharging through a small section of chute into 40 cu. ft. bottom dumping buckets under the cableway. The aggregates were teamed or trucked in from the nearest siding, 4 miles away, and dumped on wooden platforms to be rehandled into the bins by a steam operated clam shell. Water for the mixer, boilers and for camp use was obtained from the creek, being pumped through pipes up the sides of the ravine. On the cableway tower, on the west bank, a 1,000 gal. tank was constructed to act as a reservoir.

The steel girders were originally on old Intercolonial Ry. bridges that had been replaced by heavier structures. The chords consisted of two 12 in. channels and 24 in. cover plates and the web members comprised a double system of angles and bars forming 5 ft. panels. They were demonstrated to be amply serviceable for highway use. New brace frames and laterals were installed prior to erection.

An interesting feature of the construction was the fact that these girders were erected entirely without false work, the girders being carried across the openings by means of a pilot or pair of triangular trusses, 60 ft. long, suitably cross braced. This pilot was bolted on the end of the girders and securely tied to the shoe plates. The pilot was handled by the cableway and connected to the girders as soon as the latter were out far enough to enable the pilot to reach the pier. Each girder was pulled from the forward end of the last girder placed, moving on greased rails, the motive power being supplied by the carriage of the cableway, with a series of blocks and tackle. When the girder was moved out to to correct position, it was jacked down to its bearing on the pier. The next girder was then run out over those in place and erected in a similar manner.

When the girders were erected, form work for the deck was placed and the concrete poured. Reinforced concrete beams are spaced at 5 ft. centers and are covered with a 7½ in. slab. The curbs were cast integrally with the deck. The bridge railing consists of precast panels set up in position in recesses left in the curb. Forms for the posts and upper rail were then clamped around them and the concrete poured.

The bridge was constructed and designed by Norman [illegible] Limited, contractors, of Toronto.

How to Increase Production in the Building Trades*

By SANFORD E. THOMPSON,

of Thompson & Lichtner Co., Consulting Engineers in Industrial Management and Construction, Boston, Mass.

In the building trades skilled and unskilled workers are actually employed from 60 to 80 per cent of the time. This means not merely that nearly every workman is looking forward with dread to the day when his job is finished, but it means also that the employer is paying in actual wages from 25 to 80 per cent more per day for his labor than if the men could work continuously.

Of nearly as great importance to the worker as the question of pay, are annoyances due to lack of proper materials, tools, and equipment, and waiting for work when on the job.

Fundamental causes of restriction of output by the worker are lack of appreciation of the necessity for doing a good day's work in order to maintain a good day's pay, and, even further than that, the actual belief of many workers that it is incumbent upon them to work slowly in order to make the work go around. These fundamental causes of restriction must be counteracted (1) by education, (2) by inciting the workmen to greater production through incentives, and (3) by the determination of actual time standards so that the employer will know just how much work a man ought to accomplish in a day.

In the factory, in place of the old "drive," methods are being substituted—definite methods of planning and expediting the work. Method is being substituted for brute force.

In an Ohio rubber plant is was found possible, for example, through planning and analysis, to increase output of the men in some of the departments by more than 40 per cent. In construction similar results are possible. Actual experience of the writer in house construction shows that 10 to 60 per cent can be saved in actual cost by adopting factory methods. In trenching in very stiff tenacious clay the following results were obtained:

Operation	Unit Cost Ordinary Methods	Improved Methods Unit cost
[illegible]	[illegible] per cu. yd.	[illegible] per cu. yd.
[illegible]	[illegible]	[illegible] per lin. ft.
[illegible]	[illegible] per cu. yd.	10 ct. per cu. yd.

Increase in output in construction involves:

A. Economic design and outlay.
B. Selection of best tools and materials.
C. Simplifying the work.
D. Fixing in advance the amount of work to be done by each man.
E. Giving the men a definite money incentive.
F. Eliminating lost time waiting for orders, waiting for materials, looking up tools, using improper tools, etc.

Considering these as working programs, Construction will increase and develop in proportion to our ability to develop [illegible] economies of construction operation, and in the second place harmonious relations with our workmen which will give them an incentive either financial or otherwise [illegible] from day to day and from hour to hour [illegible] harmony with the employer.

Number of College Students in 1921.—According to statistics compiled by Dr. George F. Zook of the U. S. Bureau of Education, the attendance at universities, colleges and professional schools this year reached [illegible], which is a gain of [illegible] per cent over the attendance in the war year of 1917-[illegible].

From the Notebook of an Engineer*

By R. FLEMING,

American Bridge Co., New York City

A symposium, "What Department of this Periodical do You Read First," is always interesting. For himself, the writer puts first, "Inquiries from Correspondents," "Questions and Answers," or "Letters to the Editor." From material gathered from such departments the questions and answers following are selected. It is true that many of them, both questions and answers, are trivial, but they serve the purpose of showing how some minds work when approaching a more or less technical question.

The Proper Way to Proceed in Designing a Factory Floor.—In designing a factory floor the law requires a weight of 250 lb. per square foot to be allowed for. What is the proper way to proceed to design the floor, or to get the proper size of the girders, and the size and spacing of the iron floor beams (I-beams) from this given weight?

The proper way to proceed, if the factory is in Jersey City, is, via any one of the North River ferries, to the office of any one of a number of civil engineers below Chambers Street, New York. He will design the floor properly, so that it will both be economical and stand up under its load. Otherwise there is danger that neither end will be fulfilled. As the above letter reaches us anonymously we could not take notice of it, but in the interest of science and human life give this much advice free.

—Engineering News, April 16, 1887.

Wind Pressure Calculation for Eiffel Tower.—In answer to a query as to what would happen if his proposed 1,000 ft. tower in Paris should topple over, M. Eiffel said that it was calculated to withstand a wind pressure of 61½ lb. per sq. ft.; counting the lattice work as full surfaces. He further remarked that in the event of a wind of this power sweeping over Paris, little would be left standing there—except the tower.

—Engineering News, March 12, 1887.

How to Find the Sine of An Angle.—When no tables are accessible, how would you get the sine of any given angle?

The sine of an angle may be obtained approximately from the following formula, in which a is the length of the arc of the angle corresponding to radius 1:

$$\text{Sine } a = 3.6 \times \frac{a}{\pi} - 3.2\left(\frac{a}{\pi}\right)^2$$

Thus, for instance, as a then is

$$2\pi \times \frac{60}{360} = \frac{\pi}{3},$$

the sine of 60° is approximately

$$3.6 \times \frac{1}{\pi} \times \frac{\pi}{3} - 3.2\left(\frac{1}{\pi} \times \frac{\pi}{3}\right)^2 = 3.6 \times \frac{1}{3} - 3.2\left(\frac{1}{3}\right)^2$$

$$= 0.844 \text{ (correctly } 0.866)$$

The sine of 45° is

$$3.6 \times \frac{1}{\pi} \times \frac{\pi}{4} - 3.2\left(\frac{1}{\pi} \times \frac{\pi}{4}\right)^2$$

$$= 3.6 \times \frac{1}{4} - 3.2\left(\frac{1}{4}\right)^2 = 0.7 \text{ (correctly } 0.707)$$

The sine of 30° is

$$3.6 \times \frac{1}{\pi} \times \frac{\pi}{6} - 3.2\left(\frac{1}{\pi} \times \frac{\pi}{6}\right)^2$$

$$= 0.6 - 0.089 = 0.511 \text{ (correctly } 0.5)$$

—Home Study Magazine, Nov., 1897.

To Find the Length of An Arc.—I am told that the difference between the length of an arc and its chord at the surface of earth is 1 ft. in 34½ miles. I want the length of the former for a difference of 1 in. How am I to calculate it?

I have found the following (approximate?) formula amongst some old notes in Gillespie's "Geometry." If in a circle of radius r, c is the chord of an arc a:

$$c = a\left(1 - \frac{a^2}{24r^2}\right)$$

Taking the radius of the earth as equal to 3,960 miles, the difference in question by this formula is just 7 in. in an arc of 34½ miles.

—English Mechanic and World of Science, Oct. 24, 1919.

Life of Steel-Frame Building.—What is the estimated life of a steel frame building, and is there any probability, after 300 or 400 years, or even longer, that a building of this kind may suddenly collapse due to the weakening of the steel frame caused by oxidation?

There is little data from which the probable life of the steel frame as employed in buildings of the office type can be even approximated, but it has been determined from buildings of this character erected 20 years ago that the corrosion of the steel is exceedingly slight. It would not be a rash statement to say that the

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*Abstract of [illegible]

*From the December issue of Engineering Education.

[illegible] would extend [illegible] over the period of [illegible] years. It has [illegible] that any [illegible] in a [illegible] in place they are [illegible]
—[illegible] 1900.

Profitable Life of Fireproof Office Building.—The longevity of a [illegible] office building is of [illegible] than academic interest. Members of the [illegible] Association of Chicago were asked their opinion [illegible] in a [illegible] pending before the Income Tax authorities at Washington. Six directors prepared individual opinions, the consensus of which was that "it is not safe from an investment standpoint to assume that the profitable life [illegible] best fireproof office building in Chicago will exceed from [illegible] to [illegible] years from the date of its construction."

The Bulletin of the Association (November, 1920) lists [illegible] prominent office buildings that [illegible] (with two exceptions) after lives of less than [illegible] years to make way for more "modern" buildings. What [illegible] in Chicago will probably be experienced elsewhere. It is not because of physical deterioration that a many-storied office building is torn down. Increased ground values, meaning higher taxes, and the attractions of the improved equipment of newer buildings often necessitate [illegible] replaced by a building more "up to date" and usually with more stories.

Effect of Synchronized Vibrations on a Bridge.—I have heard it said [illegible] a steel bridge [illegible] at the bridge at the same [illegible] Is this so? . . . I understand [illegible] the dog's trot that [illegible] wrecks it.

[illegible] will shatter almost anything. [illegible] pitch is known [illegible] a glass goblet. . . . When a [illegible] it imparts a series [illegible] to the bridge which are [illegible] The [illegible] each in itself extremely small sets up a series of vibrations in the bridge which are naturally accumulative. [illegible] to deal with the matter theoretically and assume an [illegible] the vibrations set up by the trot of the dog would [illegible] point, reach a magnitude which would wreck the bridge. Practically, of course, no such results are possible. We have personally seen very decided vibrations set up in a bridge by a dog trotting over it.
—[illegible] American, [illegible]

Space Occupied by 1 Ton of Coal.—How many cubic feet should be allowed for a ton of coal?

To be on the safe side, provision for storage [illegible] should allow not less than about 40 cu. ft. per ton of 2,[illegible] ft. per ton of 2,240 lb.
—Power, F[illegible]

Kinds and Efficiencies of Riveted Joints.—How [illegible] riveted joints are used in boiler work and what is the ef[illegible] strength of each compared with the solid part of [illegible]

The different kinds of boiler joints and their [illegible] efficiencies, as usually designed in good joints, are [illegible]

Lap-joint, single-riveted, longitudinal or girth..	[illegible]
Lap-joint, double-riveted, longitudinal or girth..	[illegible]
Butt and double-strap joint, double-riveted	[illegible]
Butt and double-strap joint, triple-riveted	[illegible]
Butt and double-strap joint, quadruple-riveted	[illegible]

—Power [illegible]

Stress in Rectangular Plate.—Please give [illegible] the stress in a rectangular plate when sup[illegible] upon all sides. Give formula for a square plate under similar [illegible] If possible show how the formulas [illegible]

No one has as yet derived formulas for [illegible] under these conditions, the mathematical [illegible] of no approximations that [illegible] value.
—Home Study for [illegible]

In contrast to the answer given to the last query see Johnson's "Materials of Construction Rewritten." Under "Approximate Determination of the Strength of Flat Plates under Normal Forces" are given equations answering the questions asked.

Principal of Virtual Velocities.—Questions as,

What is the meaning of the term, circular mil?
What is meant by [illegible]
What is latent heat?
What is the [illegible]

are asked again and again. To the technical reader it may seem that they could easily be answered by reference to a dictionary or a textbook. But it should be remembered that the questioner may not [illegible] knew might not have [illegible] The answers given to such questions are often worth repeating. One question and answer will be quoted.

[illegible]

[illegible]
—Machinery, [illegible]

Willow Wand Water Finder Myth.—A question often asked and which invariably brings a protest to the answer given is some form of.

Is it true that if a peach twig with a Y shape is inverted and carried over the ground it will revert to the opposite position at all points where water may be found in quantities sufficient for a well?

The answer that was given in this particular instance is too long for quotation. It conformed to the opinion of men with even an inkling of scientific knowledge that there is absolutely no scientific reason why any action such as that mentioned should take place, and the results, if any were obtained, were due to purely psychological reasons.

The myth has been controverted for centuries. The Encyclopaedia Britannica devotes a page to the divining rod. From far Honolulu comes the bulletin of the Hawaiian Engineering Association, July, 1916, bearing the title, "A Hypothesis Regarding the Use of the Divining-Rod in Locating Underground Water." In 1917 the U. S. Geological Survey issued "The Divining Rod, A History of Water Witching with a Bibliography," by Arthur J. Ellis, a bulletin of 60 pages. Of these, 28 closely printed pages are given to the bibliography. Each year adds to the astonishing number of articles, pamphlets and books already written on the subject. Why they should so readily obtain a hearing is a mystery, but the human kind likes the mysterious.

Oscillation of Structures During High Winds.—The oscillation of chimneys and high buildings during severe winds is a matter of interest. The following is from Power, Dec. 5, 1911.

Do not brick and cement chimneys oscillate in high winds? How much out of center would the top of a well-constructed chimney, 125 ft. high, [illegible] in a [illegible]-miles-an-hour wind?

All chimneys oscillate in a wind. It is practically impossible to state what the oscillation would be in the case presented. The factors which influence the oscillation of a brick chimney are its diameter, the taper of its sides, the material and workmanship and the rate at which the wind is [illegible] Assuming a chimney of 125 ft. in height and [illegible] with a 2 per cent taper and built with fairly good care and material, the oscillation in a [illegible]-miles-an-hour wind should be about [illegible] inches either side of the true center line.

Careful observation made by Professor Omori on the Saganoseki, Japan, reinforced concrete chimney of 570 ft. height and 26 ft. diameter showed at the top an amplitude of vibration of less than 1 in. for winds of [illegible] miles an hour though it reached 7.32 in. for a wind of 78 miles an hour.

For a choice bit of nonsense the following, taken from a New York daily, does very well.

The answer to the query [illegible] Woolworth [illegible] buildings sway in [illegible] The top of [illegible] steeple sways about [illegible] St. Paul's steeple sways much more than this. Washington Monument sways 4 or 5 ft. in a [illegible] 7 or 8 ft.

Tenants of the Woolworth building need not worry, but why are non-technical men so ready to express opinions on technical subjects?

Recommendations on Conduit Placed in Cinder Concrete

A special sub-committee of the N. F. P. A. Electrical Committee was designated last spring to investigate the corrosion of electrical conduit in cinder fill, to report its findings and make such recommendations for code provisions as might seem desirable.

The subcommittee was composed of one representative each of the N. A. E. C. & D., Associated Manufacturers of Electrical Supplies and the American Institute of Architects. The committee prepared a questionnaire designed to secure a national record of experience with conduit embedded in cinder fill or cinder concrete floor fill and in cinder concrete. The questionnaire was sent to 111 electrical contractors, consulting electrical engineers and architects selected with respect to the class of work handled and geographical distribution. The questionnaire brought a 40 per cent response and a fund of valuable opinion based upon experience and research.

The subcommittee made its report to the Standing Committee late in August. Portions of this report of direct interest to architects are quoted in the Journal of the American Society of Architects, from which we have taken the matter that follows. It should be borne in mind that the report has not been acted upon by the Electrical Committee.

The replies to this questionnaire indicate the national experience with pipe conduit embedded in cinder concrete floor fill (cinder concrete floor fill being usually a very lean mixture of portland cement and cinders or clinker, the residue from the combustion of either anthracite or bituminous coal) to be that where moisture is present, the conduit corrodes very rapidly. Moreover, it appears that the rate of corrosion is little affected by the character of the protective coating on the conduit.

Enameled, galvanized and sherardized conduits have all failed in periods ranging from ¾ of a year to 7 years, depending upon the amount of moisture present. The explanation of this condition is that all cinders contain sulphur in varying amounts, which, by the admixture of moisture is converted into sulphurous acid. This acid attacks not only conduit, but also water, gas, steam and other ferrous pipe with which it comes in contact.

Chemically speaking, the enameled coating should protect the conduit from attack by acid. But this coating is easily abrased and destroyed by traffic abuse after the conduit is installed and before the concrete is placed. Any one familiar with construction, knows how difficult it is to control such destructive traffic in unfinished buildings. Conduit for branch circuit work usually is cut and threaded on the job and the scores in the coating made by the teeth of the vise on the cutting bench, and threads exposed at couplings are points at which the acid reaches the steel and corrosion begins, spreading under the protective coating, no matter what its character.

It appears that when the proportion of portland cement in the cinder concrete is relatively large, or, say, 1 part of cement to 5 or 7 parts of cinders, corrosion of the conduit, even when moisture is present, is not a serious matter. The explanation of this phenomenon is that the cement, in hydrating, gives off free lime which has a neutralizing effect upon the acid.

If it were possible to prohibit the placing of pipe conduit in cinder concrete except where the concrete contained a certain minimum proportion of cement and if it were possible to enforce the rule, the placing of conduit in such cinder concrete might safely be permitted. But such control can not be made effective through the electrical code and electrical inspection and indeed it is doubtful whether such control would be effective even if adequate provision were made in building codes generally.

The plain fact is that cinder concrete should not be used in buildings where it comes in contact, not alone with conduit, but also with ferrous pipes of any kind. The Electrical Committee, through the National and suitable national bodies affiliated with the N. F. P. A., should undertake an educational campaign among architects and engineers to convince them of the desirability of avoiding the use of cinders and cinder concrete where they will come in contact with ferrous pipe.

There are various protective measures which, if adopted and thoroughly executed, would prevent the corrosion of conduit. The conduit might be given a heavy coating of asphalt paint after installation and before the cinder concrete is placed. Small defects in this coating, however, would render it valueless, and there is no assurance that such a coating would be so applied as to be free from defects.

Adequate protection to the conduit might be secured through placing about it an envelope, not less than 1 in. thick, of portland cement and sand mortar. The cost of such protection, however, would probably be prohibitive; and if it became general practice, it would doubtless raise a question of trade jurisdiction.

The special committee realizes the futility of making any definite recommendations that cannot be made effective through the electrical code, since that code is the only thing with which we are concerned and through which we have any jurisdiction.

Experience leaves no room for argument to controvert the assertion that conduit and cinders should not be allowed to come in contact. We cannot prohibit the use of cinders under the electrical code, but we can prohibit the placing of conduit in cinders or cinder concrete, and that is the committee's recommendation.

The inclusion of such a prohibitory clause in the code might at first seem to impose an unreasonable hardship upon those who design and construct buildings. But the committee is fully persuaded that such is not the case. With a little thought and the application of a little knowledge and ingenuity, it will be found wholly feasible and highly desirable to adopt a new practice in the matter of locating horizontal branch circuit work. It should be borne in mind that there are very large areas in the country where cinders are not available for structural purposes, and architects and engineers in such regions have solved the problem satisfactorily. In still other places where cinders are commonly used, certain architects and engineers, profiting by past experience, consistently prohibited their use. So the committee does not feel that it is recommending a step that is radical or that will result in hardship."

Galvanizing an Effective Protection.—The foregoing was published in the November issue of the Journal. It induced comment and discussion, and in January the Journal published a letter from Mr. Bassett Jones of Meyer, Strong & Jones, from which we quote in part.

Some few years ago the writer gave a great deal of attention to the question of conduit in cinder fill, carrying on extensive and careful chemical and physical tests, both in the laboratory and on the building site for the purpose of determining what sort of protective coating could be applied to steel pipe that would protect it from the action of the sulphurous acid set free by dampness in the cinders.

These tests originated in the discovery that practically every form of rust protection applied to conduits then on the market disintegrated very rapidly in cinder fill. We had records of numerous cases where the conduit had been completely destroyed in a comparatively short time. An investigation of the old Manhattan Trust Co. building, at the corner of Wall and Nassau Sts. in New York, at the time of its destruction, as well as an investigation of the old Pabst Bldg., which stood on the site of the present Times Bldg., together with numerous other cases showed one interesting fact, that all hot galvanized pipe that had lain in the fill had remained intact, and the writer then suggested to conduit manufacturers that a hot galvanized protection be used on electrical conduit.

This, however, did not seem to quite fill the bill as at the time a large amount of electro-galvanized conduit was being placed upon the market. The writer therefore undertook to carry out experiments and tests to find out whether or not electro-galvanizing could be applied to conduit in such a manner that it would not disintegrate when buried in cinder fill.

Much work was done on this phase of the subject and eventually we discovered by a series of long tests in buildings under construction that if electro-galvanized conduit was used in which the galvanizing would meet the standard American T. & T. four-dip test for hot galvanizing that such conduit resisted the effect of the cinder fill equally as well as the hot galvanized pipe.

It was found that in order to make the electro-galvanized [illegible] that it was necessary to leave the conduit in the [illegible] bath for an additional period of time, generally [illegible] an hour, and that when this was done the conduit met the test and stood up under [illegible] conditions when buried in cinder fill. [illegible] conduit has been taken out of [illegible] fill by the writer for various periods after the installation up to [illegible] years and it has proved in every case to be [illegible] as good at the end of [illegible] years as it was the day it was installed.

At these tests samples of practically every make of conduit on the market were used under actual building conditions and with the exception of the conduit meeting the four-dip test the results when the building was completed, was a collection of badly rusted pipes.

This office has therefore made it a practice for a number of years to specify that all electro-galvanized or hot galvanized conduit shall meet the standard American T & T four-dip test for hot galvanizing, and [illegible] by the corrosion of conduit by the [illegible] in the cinder fill on the writer's installation [illegible] to these specifications has ceased.

Our experience shows that a considerable [illegible] of the damage caused by corrosion is due to the mechanical abrasion of the conduit before the cinder fill is laid. The conduits are laid on the floor slabs and [illegible] building material is dumped upon them from wheelbarrows. Wheelbarrows are wheeled over them and the [illegible] probably as hard treatment as it is possible to give it without crushing the pipe. Indeed, in some cases we have found pipe crushed due to this cause.

I mention this because there is no question in our minds that the best rust protection for conduit is acid proof enameling, black or otherwise, but actual measurements at buildings have shown that in many cases at least one-third of the enameling has been removed from the pipe by mechanical abrasion before the fill is placed. This left one-third of the bare steel open to the immediate attack of the acids in the water used in the fill.

I should draw your attention to the fact that the American T & T four-dip test for hot galvanizing which is applicable as mentioned above to electro-galvanizing does not apply to Sherardized products, for the zinc applied by the Sherardizing process is mixed with iron particles which prevent the test from operating propertly.

The only known suitable test for protective value of the Sherardized coating is the salt spray test which must be carefully carried out and is not easy to use, but such tests as well as other chemical and physical tests of Sheardized products indicate that this form of protection, if the Sherardizing is properly executed and the coating contains at least 200 milligrams of zinc per square inch of surface, is equally as good as that required in the cases of electro-galvanizing or hot galvanizing by the Standard American T & T four-dip test.

My experience has led me to believe that the deleterious action of the cinders ceases after a reasonable time unless of course water is more or less continuously added to them. In other words, the action of the cinders on the [illegible] exists only during the time the cinders retain their moisture. If there is enough zinc deposited on the pipe so that the amount removed by the action of the sulphurous acid in the moisture contained in the cinders can not remove all of the zinc before the cinders have become dry, the pipe will remain intact indefinitely. It is of course probable that if through leakage of other pipes the cinders remain moist no matter how much zinc is applied to the pipe [illegible] eventually become corroded.

It may be of interest to add that in tropical climates where the air is more or less charged with [illegible] hydrogen from decaying vegetation, the zinc [illegible] galvanized pipe is disintegrated with extreme rapidity by the air alone. In this case, the only resource is to paint the pipe with asphaltum as soon as it is received. [illegible] the hot galvanizing on pipe kept under a shed disintegrated to a white powder in 10 days. Other forms of galvanizing, except high grade Sherardizing, disintegrated [illegible].

To sum up I might say that provided the proper amount of zinc per unit of area is properly applied to the pipe, either by the electro galvanizing process, the hot dip process, or Sherardizing process, the pipe will not be corroded in any reasonable length of time in cinder fill, unless the fill remains damp.

The First Copartnership Housing Venture in the United States*

By CLARENCE S. STEIN

[illegible]

How shall the city or state help meet the housing [illegible] in a [illegible] way? New York has [illegible] by [illegible] buildings put under way before April, [illegible]. As a result we have increased construction, but [illegible] of as poor a standard as the [illegible]. The city is helping to pay the bill, through non-collection of taxes, but it is demanding nothing from the builder, [illegible] planned buildings nor easier terms for the tenant. Milwaukee is also participating in housing, but [illegible] in a manner that will eliminate speculative profit and in which the participation of the [illegible] taxpayers. [illegible] New York City [illegible].

The Milwaukee plan is a [illegible] of The Housing Commission of that city. [illegible] that it more clearly and [illegible] the problem that was [illegible] the country than has any other report published in this country when it said:

"The solution of the housing problem involves:

(a) The elimination of [illegible] residential districts.

(b) Zoning of the city to safeguard all residential districts.

(c) Economical and adequate planning of streets, transportation, sewage, disposal, water supply, lighting, planting of trees, etc.

(d) Elimination of waste in construction of homes.

(e) Acquiring for wage earners the benefits of ownership without interfering with labor mobility.

(f) Legislation aiming to stimulate the creation of wage earners' homes.

(g) Public instruction as to the possibilities of housing betterment."

The practical outcome of the report was described by William H. Schuchardt, F. A. I. A., the then chairman of the Commission, and now president of the Public Land Commission of the city of Milwaukee, in a recent address from which we quote:

"In the spring of 19[illegible] the Mayor of Milwaukee, the Health Commissioner, the Building Inspector and members of the Commission appeared before the legislature and successfully urged the passage of a bill empowering municipalities and counties to purchase stock in co-partnership housing enterprises. Then followed a campaign of persuasion for the scheme was often times termed stupid, paternalistic, socialistic, or communistic. It was opposed by many of our leading manufacturers, by the real estate board and by other so-called practical, hard-headed business people. The men who sponsored the scheme or who approved of it were condemned as being visionary, mere impractical dreamers. They had no precedent in this country to point to and European experiences were easily discounted because conditions on the other side of the Atlantic [illegible] which obtain in this country. But little by little the circle of friends increased. [illegible] and last spring it was deemed possible to organize the Garden Homes Corporation. The city of Milwaukee, by vote of the Common Council, purchased $50,000 worth of stock, the county of Milwaukee [illegible] of stock and various manufacturers have so far subscribed to about [illegible] worth of stock. [illegible] has gone on record as approving the scheme and has pledged itself to raise [illegible].

"All sails are now set. About 30 acres of splendid land were purchased, architects were employed to draw plans of houses, the city planning [illegible] the street layout and in September last some two or three hundred people witnessed the turning of the first spadeful of sod by Mayor Hoan. [illegible] construction and more will be erected as soon as sufficient funds are in hand.

---

*[illegible]

[illegible]

The [illegible] scheme of ownership was developed in [illegible] some 20 years ago and has met with considerable [illegible]. It is designed primarily to mitigate the [illegible] of ownership and at the same time secure for the occupant [illegible] all of the advantages of individual ownership. It aims to do away with all speculative values and [illegible] to make the wage earner's investment both safe and liquid.

[illegible] a concrete example: We are assured that [illegible] a six room house for about $3,800, and we know that the land, a 40x100 ft. lot, will cost with street, sewer and [illegible] improvements another $700, making a total investment of $4,500. The prospective occupant subscribes [illegible] worth of common stock and pays in cash [illegible] first installment, let us say $400. His charges will then be as follows:

[illegible]	$1[illegible]
[illegible]	[illegible]
[illegible]	6.00
[illegible]	20.00
[illegible] fund	20.00
[illegible]	[illegible]
or $[illegible] per month, a total of	$267.00
[illegible] $4,100	[illegible]
[illegible] stock	1[illegible]
	$5[illegible]

The first year's total charges will therefore be $4[illegible] per month, [illegible] is investment and interest. At the beginning of the [illegible] year he will have paid [illegible] his stock subscription [illegible] charges would be as follows:

Taxes and other expense	$267.00
[illegible] stock	120.00
5 per cent interest on $2,[illegible]	1[illegible]
	$[illegible]

[illegible] per month, of which $22.[illegible] is investment and interest. At the [illegible] of the seventh year he will have paid in $[illegible] [illegible] and the total [illegible] will be $452 for the year [illegible] per month and [illegible] stock is paid for, when, [illegible] his monthly [illegible] is only $22.2[illegible].

"While these charges may seem high for the first years it must be seen that there are no items other than contingent fund and administration charges which the occupant would escape as an individual owner. These two items costing a little over $3 per month, assure him against serious loss should he find it necessary to move to another locality. For in that event he does not need to sell out at a sacrifice in a buyer's market. Should circumstances require his separation from the company, he merely sells to the company his stock at a surrender value which varies with the length of occupancy as does the cash surrender value of a life insurance policy. The company in turn sells this stock to another prospective occupant.

It must also be borne in mind that his investment of $4,500 gives him a home which he could not possibly buy at [illegible] price elsewhere for no profit whatever is charged in arriving at that figure. Yet it must be admitted that a monthly outlay of $50 a month, whatever it may include, is beyond the reach of the unskilled laborer. We can not here discuss that phase of the problem. We must for the moment accept what appears to be inevitable, namely, that the unskilled laborer can not buy a home equipped with all the improvements required by ordinance or by standards of living which certainly are an improvement on those of our [illegible].

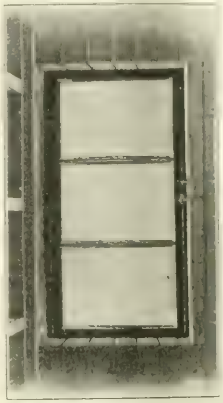
"The question has often been asked why the occupant does not [illegible] title to the property he occupies when he has paid for all his stock. I wish to emphasize that he does not purchase property, but common stock. It is not the purpose of the company to procure homes at rock bottom prices, sell them at cost to the occupant and then permit him to profit [illegible] another wage earner. The company, in its effort to [illegible] all speculative profits must control the title [illegible]. The so-called unearned increment of land value shall benefit no individual unless the stockholders [illegible] [illegible] [illegible]. The company aims to protect the occupants against [illegible] [illegible].

[illegible] it is proposed that a committee of [illegible] the common stockholders will [illegible] [illegible] [illegible] [illegible] betterment of living conditions. It is the aim of the company that restrictions shall interfere as little as possible with individual freedom. They will be imposed only where it is necessary to protect the common good so that the benefits to be derived will not be offset by annoying interference. In as much as the common stockholders, that is, the occupants, will gradually supersede the preferred stockholders in control, because the preferred stock is retired as the subscribed for common stock is paid for, it is to their own interest to so guard their common possession that the advantages gained may not be lost.

"It has been predicted that it will be difficult to find a sufficient number of families who can be induced to subscribe to common stock under a scheme such as has been outlined. We are more optimistic than to believe that, for the idea has been well advertised and although we can now build only about 50 houses we have received over 500 applications to date. I think that our embarrassment will lie in the selection of occupants rather than having empty houses on our hands."

New Steel Frame Basement Window

A new basement window in steel, the cost of which is claimed to be as low or lower than wood frame windows, has been placed on the market by the Detroit Steel Products Co., Detroit, Mich. The chief argument advanced in favor of the steel window is that it admits 40 per cent to 50 per cent more light for the same sized masonry opening. This extra illumination is secured through the use of narrow solid rolled steel bars in both frame and sash, thus eliminating the wide wooden members and permitting the use of larger glass lights. Another advantage is the fact that the steel window cannot warp nor stick. While the new steel window is provided with a lock already attached, it is so designed that a padlock may be used in place of the one provided. This would prevent burglars from cracking out a pane of glass near the lock and opening the window by reaching in. The new window comes already assembled. There is no planing, fitting nor hanging of sash to fit the frame. The ventilator is removable, being hung at the top by two hinge pins on the inside of the frame. By merely removing these pins the ventilator may be taken out and sent away to be glazed. If at any time, a pane of glass is broken, the owner can remove the pins and lay the ventilator across his bench and glaze it at his leisure and in perfect comfort. Another advantage in the handling of the steel window is the fact that the sill is level instead of being sloped to the outside as in wood frames. The new steel windows are made in four types and sizes at present, these being standard construction and in stock in warehouse. These types and sizes are as follows:



New Steel Window.

[illegible]	[illegible] glass, over all	[illegible] 2 ft.	[illegible] by 1 ft. 11¾ in.
[illegible]	[illegible] glass, over all	[illegible] 2 ft.	[illegible] by 1 ft. 11¾ in.
[illegible]	[illegible] glass, over all	[illegible]	[illegible] by 2 ft. [illegible] in.
[illegible]	[illegible] glass, over all	[illegible]	[illegible] by 1 ft. [illegible] in.

The windows are shipped without glass, but glazing clips are supplied, these being small wire clips, similar to those that have always been used in glazing steel sash. An ingenious detail has been worked out to hold this steel basement window solidly in the wall. The outside bars of the window are not intended to [illegible] in the building construction in the way usually employed where steel sash is used. The building construction is intended to come up flush and [illegible] against the window on both sides, and at top and bottom, anchorage being secured by means of four straight flat pieces of steel about [illegible] in. wide by 4 in. long. These are [illegible] in the mortar joints in such a way that the ends extend about [illegible] in. into the channel frames at the jambs of the window. Two clips are used on each side, and these are sufficient to anchor the window solidly.

Annual Convention Associated General Contractors of America

A definite assurance that construction recovery is under way and that it is the first phase of a general business revival sums up the results of the construction conference held in Cleveland Jan 17 to 19 by the Associated General Contractors of America. Evidence of this fact both statistical and informal abounded in the discussions of the delegates and in the papers presented as a part of the program.

Col Leonard P Ayres, who was chief statistical officer of the A. E F., and who is now vice president of the Cleveland Trust Co., expressed the belief that prices will continue to fall, intermittently, for 10 or 20 years more but conveyed assurance that the construction industry will be immune to many of the embarrassments of the coming period, because it supplies a market in which there is a latent demand equal to 2¼ years' normal production of building.

"In other words," said Col. Ayres, construction can go along for nine years at 25 per cent above normal and only fill the normal demand by the end of that time

Col. Ayres said that building finance problems had commenced to adjust themselves, through greater abundance of money. "The acrimonious discussions between ourselves as contractors and ourselves as bankers are about over," he remarked. "Within six months so much money will be for borrowers that owners will be able to arrange building loans on pre-war terms."

Charts shown by Col. Ayres indicated a subnormal volume of building for every year since 1912. Even the apparent large building figures for 1919 and 1920 were only apparent, he declared. The cost was large but the building was far behind even the current needs of the time. The only time in the last nine years when the volume has gone above average requirements was for the last few weeks of October, 1921. This was chiefly residence building, but it shows in Col. Ayres' opinion that the tide is rising rapidly. He declared that building prosperity is always the first phase of general revivals and that it disseminates prosperity more widely than any other type of activity.

Determined not merely to predict prosperity, but actually to observe it, the constructors arranged a program in which the theme of waste elimination was constantly emphasized.

J. Park Channing of Boston, who succeeded Herbert Hoover as chairman of the Federated Engineering Organizations, gave the major paper of the conference on this subject and said that 25 per cent of the responsibility for waste rests on labor, 50 per cent on management and the remaining 25 per cent on outside relationships. In respect to industrial accidents, however, he asserted that 85 per cent of the responsibility rests on the individual workman.

Constantly changing personnel is a case of waste treated by the speaker and he recommended measures to increase the period of active work so that employment will be more nearly an annual affair. He expressed faith in the method of reasoning with employes rather than ordering them, when labor emergencies are encountered. Material control was treated as a major time-saving proposition in the building business.

F. L. Cranford of New York, former government director of the Muscle Shoals nitrate plant, discussed a 20,000-mile trip taken by officers of the association in the interest of construction revival. He expressed the opinion that labor has reached pre-war efficiency and that the chief retarding factor is the general belief that material is too high.

Cost-plus contracts, fee contracts and efforts made in some projects to eliminate the general contractor were discussed. D. A. Garber of New York voiced the belief that few architects and engineers can qualify to direct a building project in the place of the general contractor. Godfrey Edwards of Los Angeles decried anything but lump-sum contracts, believing that when a builder takes a job on a cost plus or a fee basis, he is paving the way for his own elimination.

The conference acted favorably on the Kenyon bill to create a reserve fund that will stimulate construction in depressed periods.

Otto T. Mallery, from the Department of Commerce, urged that 10 per cent of all public construction funds be set aside in such a reserve, each normal appropriation for that year.

Other speakers at the convention were Ernest T Trigg of Philadelphia, president of the National Federation of Construction Industries, whose subject was "Co-operation in Construction," and Col Evans Shelby, New York, attorney, who was formerly legal advisor to the construction division of the army, who spoke on "Organization in Construction."

"The opportunity before the construction industry is very great," Mr. Trigg said, "if and when the public's confidence is secured.

"We have passed the stage when the employers and the employes can get together with themselves and with each other and determine the affairs of the third party, the public The public has come back into its power

"But, until we come to where the public's confidence is restored, construction is not going to revive."

"The obligation rests with the leaders in the construction industry to clean house," Mr. Twigg emphasized. "They must," he said, "see that the customs of the trade which hold up costs and neutralize the effects of competition, be done away with. They must also," he said, "take the initiative in promoting more cordial and economical relations with their workmen.

"You must not take advantage of the fact that now you have the whip hand," Mr. Trigg asserted. "By taking the broad view of things right now, you will bring about a condition of peace in industry where both you and your employes will share in ungrudged prosperity."

Col. Shelby outlined the steps by which the general contractors were organized for the first time during the war, an organization which preceded the one just closing its convention, and pointed to the accomplishments of its short existence as forecasting the progress which will be realized by simplifying the forms of contract, promoting research in industrial methods and improving the relations of the contractors with the material dealers and workers.

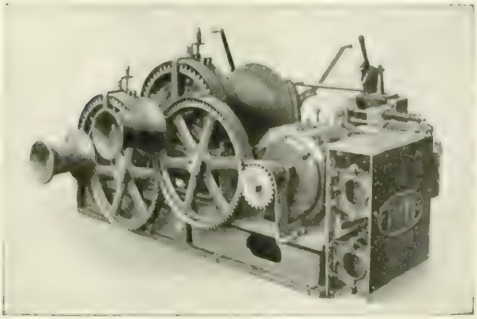
A New Drum Mixer

The Austin Machinery Corporation, Chicago, has just announced another addition to its line of contractors' equipment this time in the form of a complete line of popular-priced drum mixers Heretofore the Austin mixers have been of the cube design, the mixing being accomplished without the aid of blades or paddles, simply by throwing the batch from plane to plane with a force varying according to the speed of revolution This necessitated materials and construction of unusual strength, which naturally would reflect in the price asked In the new drum type mixer, recourse is had to the customary elevating mechanism in the interior. The consequent freedom from unusual strain has enabled the Austin people to save on construction cost and thus to meet the demand for a moderately priced mixer. The same principle has been utilized to produce a secondary line of Austin pavers. The mixers will be supplied in all standard sizes from ½ bag to 2 yd., and the paver in sizes from ½ yd to 2 yd.

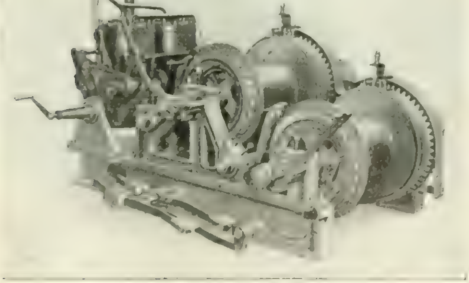
New Austin Drum Mixer.

New Contractors' Hoists

Pawling & Harnischfeger Co. of Milwaukee has standardized a line of contractors' stationary hoists, two illustrations of which are shown in the accompanying views. These hoists are made in types for electric, gasoline and belt drive, in sizes ranging from 8 HP with 8x12 drum, up to 115 HP with 18x28 drum. The same high quality electrical apparatus as furnished on P. & H. electric traveling cranes and hoists is used on all P. & H. electric-driven contractors' hoists. For the gasoline-driven hoists, motors of the types that have proven successful in P. & H. gasoline excavator cranes, trench excavators, gas shovels, and dragline excavators are used. These are in all cases of the heavy duty 4-cylinder vertical tractor type with Bosch magneto, Master carburetors, Stewart vacuum systems and air cleaners. Automatic throttle governors are provided and conveniently located hand throttles. The belt-driven types are similar except that the rear end of the bed frame is left off, and a large size driving pulley is provided on the side opposite the operators. The construction for all types is similar; the bed plates and side stands are of box and I-beam section design with heavy cross girders and bottom and top flanging. Plates are accurately planed and side-faced. Through bolts are only used and all holes are drilled in jigs and fixtures. All drum shafts are of high-grade carbon steel, turned and ground to exact size giving a fully polished bearing for the drum bushings



P. & H. 2—Drum Electric Stationary Hoist.



P. & H. 2—Drum Gas Stationary Hoist.

and oil retainers. Gears are made with cut teeth and motor pinions and gears are [illegible]. Large gears are of steel, [illegible] pressed in place on the shafts by hydraulic pressure against a shoulder.

The friction mechanism is of the standard V design, the friction facings are of specially seasoned maple, accurately turned. Brakes are operated by means of foot levers located conveniently to the operator's feet. The contact of the brake bands is insured because they are worked in on drums and peened to conform to the drum surface before placing on the hoist. This is done so that the user does not have to wear the brakes in. Counterweights are provided for all brakes, insuring a quick release.

Humboldt County Redwood Starred in Movies

The Pacific Lumber Co. has just completed a moving picture showing how the Humboldt County redwood is logged in the virgin forest, transported to Scotia, Calif., sawed in the mills, seasoned and finally sent forth into service. Beginning in January special representatives of the company will take copies of the film on tours to all parts of the country. It will be exhibited at lumber dealers' conventions, before architects' societies, at Home Building Expositions, at gatherings of specialty manufacturers, before any group which is desirous of becoming better informed regarding the lumber that comes from the monarchs of all forests. Other copies of the picture will be sent abroad in order that inhabitants of other lands, too, may visit California and know redwood. Japan is already viewing this picture. The film, which affords about an hour's entertainment, was produced for The Pacific Lumber Co. of Illinois, planned and supervised by its advertising department. The Rothacker Film Mfg. Co. of Chicago made the production.

Personals

E. A. Tewksbury has been appointed city engineer of Cuyahoga Falls, O.

W. C. Jones, architect; C. L. [illegible], engineer; W. W. Wessel, contractor; L. O. Bailey, real estate; L. C. Stephens, insurance, have been appointed members of the commission to revise the building code of Memphis, Tenn.

John P. Kennedy, civil engineer, secretary and manager of the Fifth-Street Improvement Association, has been appointed by Mayor Cryer and confirmed by the Council as a member of the Board of Public Utilities of Los Angeles, Calif.

Wells Bosworth, architect of the new Massachusetts Institute of Technology buildings, has received from the French Government the decoration of Chevalier of the Legion of Honor. Mr. Bosworth has been active through many channels in furthering friendly relations with France since he returned to this country from L'Ecole des Beaux Arts in 1900, particularly during and since the war.

W. O. Hart, lawyer of New Orleans; T. J. Green of Shreveport, president of the State Federation of Labor; George J. Glover of New Orleans, builder and contractor; W. W. Carre of New Orleans, lumber dealer, and W. P. Connell of Baton Rouge, banker, have been appointed members of the Building Contracts Commission of the State of Louisiana.

Frank L. Packard, architect, Columbus, O., has accepted a commission from President Harding to go to Rio de Janeiro as an architect and as personal representative of the United States at the Brazilian Centennial Exposition. Mr. Packard will erect buildings to house the United States exhibits at the exposition. The commission also includes erection of a new embassy building for the United States in Rio de Janeiro.

Industrial Notes

A. G. Whitfield has joined the organization of the Standard Scale & Supply Co. as district manager, with offices at 163 to 171 North May St., Chicago, Ill.

F. P. Lyons Iron Works, structural and ornamental iron, Manchester, N. H., has opened a Boston, Mass., office at [illegible] Beacon St., with G. S. Walls and E. K. Carpenter in charge.

W. H. Patterson, who has been associated with the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., for the past 16 years, has resigned to become vice-president of the Kaestner & Hecht Co., electric elevator builders, Chicago.

H. B. Price, formerly advertising manager of the Belden Mfg. Co., Chicago, who has been connected with that company for several years in various engineering, production and sales capacities, has resigned to join the advertising agency of Geo. J. Kirkgasser & Co. Mr. Price will specialize in electrical and technical advertising.

Carl G. Schluederberg, assistant to the manager of the Supply Department, Westinghouse Electric & Manufacturing Co., left New York City recently on an extended trip to South America. He will spend three months surveying electrical merchandising and business conditions in Latin America in the interest of the Westinghouse Electric Companies and agencies in Chile, Peru, Uruguay, Paraguay and Brazil.

Trade Publications

The following trade publications of interest to engineers and contractors have been issued recently:

Structural Waterproofing. [illegible] Waterproofing Co., [illegible] Exchange Bldg., St. Louis, Mo. Booklet containing information on the material and [illegible] used in [illegible] of water [illegible].

Concrete Placing Equipment. Lakewood Engineering Co., Cleveland, O. Catalog devoted to equipment for the handling of concrete [illegible] as well [illegible] tower [illegible] elevator buckets [illegible] dimension [illegible] complete [illegible] size [illegible]. Tables of practical [illegible] included.

Roads and Streets Monthly Issue

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Roads and Streets—1st Wednesday
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation (c) Quarries and Pits
(b) Management and Office System (d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings (d) Miscellaneous Structures
(b) Bridges (e) Properties of Materials
(c) Harbor Structures (f) Managament and Office System

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Concerning Future Good Roads Shows and Conventions

The notable satisfaction of delegates, visitors, and exhibitors at the 1922 good roads show and convention warrants active attention in making sure that next year's meeting, and those that follow shall be at least equally good. Of the many factors contributing to this success a few were indispensable—among them those of location and facilities. No such affair can serve its purpose to the best advantage unless held at a place where a great number of those interested find it convenient to attend, and where there are suitable facilities and accommodations.

The meetings of 1921 and 1922 in turn have been unanimously voted "the best ever held," and each was held in Chicago. This is a fairly good indication that there are advantages to be gained from the holding of all these meetings in Chicago, especially when we recall that certain of the road shows and conventions held elsewhere in recent years have been conspicuous failures

But the advantages of the Chicago location can be set forth more specifically. Its central geographical position and complete railroad connections reduce traveling time and expenses to a minimum and place it within practical reach of a maximum number of persons. Many of the delegates and other attendants at the meetings will have other business in this city, where so much of the road materials and road building equipment business centers. Not only are many thus enabled to "kill two birds with one stone," but a very considerable number are enabled to attend the show by this circumstance only. The country for a great distance around Chicago has much intensive agriculture and great and widespread road-building activities. These activities are in the hands of a larger number of men in this section than they are in many of the Eastern states, where the counties have little or nothing to do with road building. As the road show is essentially a business affair, the inducements of various "resort cities" are completely outweighed by the other reasons.

Likewise there is no virtue in the claim that fairness requires that the show be passed from one city to another. The road show is given for the benefit of the road industry and not as a means of bringing business to the cities, and the only claim that Chicago or any other city can have to it is that the interests of that industry are best served by holding the show there. Chicago's "Coliseum" provides better space than can be found in almost any other place where the show might probably be held.

This matter of space, however, requires further comment, for though better than most cities can furnish, it was still inadequate this year. The "Coliseum" and annex were overflowed, and two fortunately available adjoining buildings were pressed into service. Clearly a larger structure is necessary, and unless it is provided Chicago will lose her claim to one of the important facilities—that of adequate exhibition space. Chicago's municipal pier has the necessary space, but unfortunately is not equipped for winter heating. If a heating plant can be supplied at the pier, a very desirable solution of the problem will have been effected. Otherwise it will be up to Chicago interests to supply the necessary space by some new arrangement or perhaps by enlargement of the Coliseum. Other classes of exhibitions will have increasing space needs, and certainly it should never again be necessary as it was this year, to turn away would-be exhibitors because of lack of room.

The 1922 good roads meeting suffered from competition—unintentional but nevertheless damaging. The Associated General Contractors held their annual convention in Cleveland on the same dates that the road show was held in Chicago, and many interested people were obliged to forégo either one or the other, or to limit their attendance to an unsatisfactory fraction of each convention. It is the duty of our great national societies to keep in close enough touch and co-operation with one another to assure that never [illegible] the conventions with as much of common interest be held at the same time.

Better Edging is Needed Next to Car Rails

Any reasonably acute observer knows without being told that the street railway companies have a heavy burden in the maintenance of pavements adjoining their rails. True, we find instances of excellent edgings which have remained in good shape for comparatively long periods, but in general the pavement next to the rails requires many times as much maintenance as does other pavement. It appears that rail edging is a subject worthy of more attention than it has yet received, and a considerable increase in original cost will be warranted if it can be made to result in substantial savings in maintenance.

This is not an easy field for experiments. Nevertheless it is one which some of our large street railway interests might attack with a prospect of being well repaid for their efforts. Studies in design would naturally come first, and would be followed by experiment and by service trials. We cannot predict the outcome of such work but we suggest that there are possibilities in very large sizes of stone, concrete, metal or other materials. There might also be possibilities in small sizes, and in materials of special composition.

New York's Opposition to the St. Lawrence Waterway

Now that the International Joint Commission has reported favorably upon the "Great Lakes-St. Lawrence Deep Waterway Project," there is excellent prospect of that great enterprise being carried to completion—but not without opposition. For the moment, the character rather than the substance of the opposition is a matter for our concern. If there are valid arguments against the project, they will be given full consideration, and will be weighed against the advantages. This will require time, but it will be time well spent. This opposition, if it may be called such, is of sound character.

But an attack of another sort was launched against the project immediately upon the disclosure that it was to receive serious consideration. From New York State there came a volley of abuse for the proposed St. Lawrence route and fulsome praise for the New York barge canal, calculated to disgust any thinking man, and indicating a near panic in the minds of the senders. For days the office of Engineering and Contracting was bombarded with circulars of this character—many of them being copies of speeches by the governor of New York State. Several of them came by air mail—presumably with the idea that thereby recipients would be impressed with the active earnestness of the workers, and probably also with the fact that they didn't need to economize. The language of these circulars was such as wins applause at political meetings where audience and speaker are of one faith. As technical arguments they were worthless, and if they were circulated largely among engineers it is but further evidence of the poor judgment of the senders.

In the face of present claims by New York champions that they are not acting from self interest, we do well to remember that the New York Legislature of 1920 adopted a resolution opposing the St. Lawrence project because it "would be detrimental to the New York Barge Canal, the commerce of New York State and [illegible] would divert the commerce of the Great Lakes from its natural [illegible]."

Merely Another Example

Enthusiasts for municipal ownership and operation will object to examples taken from Chicago on the ground that Chicago is a badly administered city. On the quality of the administration we have no quarrel, but we do maintain the fitness of the example. Not only are Chicago's size and importance sufficient to make any of her official doings significant, but she is not alone in having an administration with a bad [illegible]. Take New York or Boston at the present moment, if you will, or Philadelphia or San Francisco as they have been in the not too distant past, or any number of smaller cities at various times past and present, and Chicago appears by no means solitary in her financial, economic, and moral offenses.

In the middle of January, the municipal shops of Chicago, which are reported as having been installed at a total cost of $2,766,782, were closed by the city council because they were a complete failure. According to the council's investigating committee, the city shops made an apparently good showing for a time, but made it through charging exhorbitant rates to the city departments for which they worked.

Here are a few examples as reported in the newspapers:

> "City work done at its own municipal shops cost 300 per cent of what it would have cost on the outside," said one alderman in commenting upon the action. "Some examples: The city can and does buy standard auto tires for list prices less 25 per cent, but the shops bought tires at list prices and then charged the departments 25 per cent additional as overhead. Repairs cost three or four times as much as they would have cost if we had had the work done by private firms.
>
> "Here is an illustration. A water valve, which on the outside would have cost $12, cost the city $80 in the shops. Another: A bell for a police auto, which would cost $8 to $10 on the outside, cost upwards of $80 at the shops. They charged for time on repairs, whether it was put in or not, and then added on 25 per cent overhead. What reason can you find for that?"
>
> The shops charged $5,11[illegible] to repair six particular Fords in the course of one year. That is an average of $8[illegible]—more than twice the cost of a new Ford.
>
> During the year the repairs on one Ford totaled $1,0[illegible], on another $1,083.91, and on the third $1,1[illegible]. It might be presumed that those Fords would run for years thereafter. But the subcommittee's investigators recommended that all three be disposed of four months after these repairs had been made.

New Methods of Gravel Road Construction in Iowa

Considerable change has been made in the past two years in the methods of constructing gravel roads in Iowa. The methods now followed were described by J. F. Reynolds of Storm Lake, Ia., District Engineer of the Iowa State Highway Commission, in a paper presented Jan. 18 at the 34th annual meeting of the Iowa Engineering Society. We quote from Mr. Reynolds' paper as follows:

The first thing we consider, of course, is the material available. In judging various gravel deposits, the important screen test is no longer the amount of material retained on a ¼-in. screen but is more nearly the material retained on an ⅛-in. screen. Gravel passing a ¼-in. screen but retained on a ⅛-in screen is excellent material. The very best material we could get for gravel road construction would be a material well graded and ranging in size from ⅛ in. to material that will pass a 1½-in. screen.

It has long been thought that a certain amount of clay binder was necessary in constructing a gravel road. After observation of roads constructed with both clean gravel and gravel carrying a percentage of clay, I have come to the conclusion that the cleaner the gravel is when it goes onto the road the better the road we will have.

It is true that clean gravel will not pack as quickly as gravel carrying a percentage of clay, but when it does pack it gives a much better wearing surface and the necessary clay for binding the material is worked up from the subgrade. Looking at it in another way, it is very foolish to pay for hauling clay from the source of supply to the road and to pay for the clay by the cubic yard when there is plenty of this binder material in the subgrade itself. There is only one place where I will consider adding binder to the gravel and that is where a gravel road is being constructed over a subgrade that is mostly sand. There are very few of these cases in northwest Iowa.

The next thing we consider in a gravel road construction is the subgrade. Of course, it has been long conceded that it is necessary that the subgrade be well drained, but it was only a couple of years ago when practically all counties were depositing gravel on a crowned subgrade and attempting to place the gravel in a position in which they wanted it packed. At present we insist on a level subgrade. The right man can take a 12 ft. blade grader and so shape the road that good shoulder lines are left and the surface is level from shoulder to shoulder.

After the adoption of the flat subgrade we still for some time attempted to place our gravel on this subgrade; just as it is shown on the plans. The result was that traffic would go to the shoulders of the road and would have exceedingly difficult going until the gravel packed. If this gravel was traveled on a sufficient length of time it would apparently pack on the subgrade. This would soon be broken up by heavy traffic and leave the road pitted and full of holes. It was almost impossible to maintain a smooth riding surface on the roads built in this way.

After attempting various methods of placing the gravel we finally came to the one that is now commonly in use. The gravel is deposited in the center of the road and spread out wide enough so that there remains only about an inch of material in the center. The balance of the material is on the shoulders. Under maintenance this material is brought towards the center of the road as fast as the gravel is packed. This leaves a road that at all times during construction is an easy riding road and traffic at no time encounters deep, loose gravel. If the material is brought in from the sides, we have a gravel road that is compacted from the bottom up.

A very common method of determining whether or not the gravel is properly spread is to observe the lines of traffic going over the new construction. If the traffic is all confined to the center of the road it is an indication that the gravel is properly spread because traffic naturally goes to that place in the road where it is easiest to get through.

Another method that is productive of equally good results is to deposit the gravel along the shoulders of the road and spread a small portion towards the center. The center of the road is then built up under traffic just as explained in the first method of spreading.

We have found that the method of constructing gravel road just described gives a road with about the proper amount of crown for this part of Iowa. We find that with the flat crown thus produced that all of our material does not become firmly compacted in the road, but there is a film of gravel dusting over the road which makes an excellent protection for the road during heavy traffic. It also gives the maintenance man something to work with. As soon as you see a gravel road with all the loose gravel along the shoulders or going into the side ditches it is a very good indication that the road is constructed with too much crown, and the only method I have found for constructing a road that will not have too much crown shortly after it is finished is the one above outlined.

Test of Central Plant Mixed Concrete for Maximum Safe Haul

Tests for the purpose of determining the probable safe maximum length of haul for central plant mixed concrete to be used in a proposed experimental concrete road near Washington, D. C., have been made by the U. S. Bureau of Public Roads. The results are outlined as follows in the December issue of Public Roads, the official publication of the Bureau.

How the Experiment Was Conducted.—The experiment was made in the following manner: Two batches of concrete in the proportion of 1:1½:3 were mixed in a stationary concrete mixing plant of 1 cu. yd. capacity. Potomac River sand and gravel were used as aggregates, the latter graded from 1½ in. to ¼ in. in size. An effort was made to mix each batch to a consistency having a slump of about 2 in. as measured by the truncated cone.

After mixing, the concrete was dumped directly into a 3-ton truck, the wooden body of which had previously been divided into six compartments by means of transverse boards equally spaced and each about 1 ft. high. The concrete in the two batches was dumped so that each of these six compartments contained approximately ⅓ cu. yd. After making a slump test and casting 6 in. by 12 in. cylindrical specimens for compression test, the truck was run for 30 minutes, when the contents of the first compartment were sampled for consistency and strength. The concrete in compartment No. 1 was not dumped at this time but was sampled in the truck, every effort being made to secure average samples. The truck was then run to the Arlington Experimental Station, a distance of 3 miles, where the contents of compartment No. 1 were dumped. Inasmuch as a dump body was not available for this experiment it was necessary to shovel out the concrete by hand. Its consistency at this point, however, was such that it came out readily and would probably have dumped easily from a regulation dump body. After removing the concrete from compartment No. 1, the truck was run about the station roads for 15 minutes, returned to the starting point and the contents of the second compartment deposited. Samples for both consistency and strength were likewise taken of this material, after which the operation of driving 15 minutes, dumping and sampling was repeated until all of the concrete had been deposited.

The concrete had been mixed 3 hours and 10 minutes when the last section was removed. By this time it had become so hard that it was necessary to break it up with a pick. Up to section 6, however, it was possible to remove the concrete with shovels, and, although very dry, segregation had not become especially marked. This may probably be accounted for by the fact that the concrete was mixed fairly dry in the first place, the initial slump being only about 2 in. It has been noted frequently that wet concrete will segregate more quickly and pack more readily during hauling than dry concrete.

Strength Not Affected So Long as Concrete Is Workable.—The results of the tests for consistency as well as the 28 day crushing strength tests are given in Table I. They are also shown in Fig. 1, in which the slump in inches and the crushing strength in pounds per square inch at 28 days are plotted against the length of haul in hours. It will be noted that, whereas the concrete became very dry after about one hour's haul, the strength of the cylinders prepared from the various batches was about the same. In only one case was the strength much below the general average of 3,500 lb. per square inch. This was noted in the case of the cylinders made from the concrete in compartment No. 1. Nothing in the appearance of the concrete at the time these cylinders were cast would account for the difference in strength. All of the specimens were made as nearly as possible in accordance with the recommended practice of the American Society for Testing Materials for taking field specimens of concrete, but as the concrete in the last three compartments was so dry as to show practically no slump it was necessary to use considerably more pressure in preparing the cylinders representing these sections.

The appearance of the concrete during the experiment would indicate that it could have been handled by a concrete pavement finishing machine at any period up to two hours

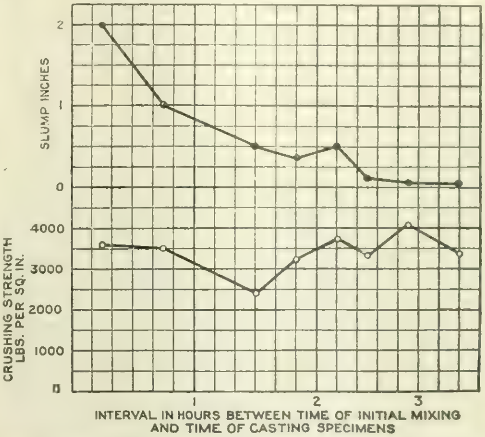


Fig 1—Results of Tests for Consistency and Crushing Strength of Central Plant Mixed Concrete.

TABLE I—RESULTS OF TESTS OF CENTRAL PLANT MIXED CONCRETE

Compartment number.	Total elapsed time.[2] Hrs.	Total elapsed time.[2] Min.	Slump[3] Inches	Crushed strength, pounds per square inch.[4] (1)	(2)	Average.
(1)		15	2	3,620	3,510	3,565
1		45	1	3,460	3,550	3,505
1	1	30	1/2	2,670	2,200	2.435
2	1	50	[illegible]	3,510	2,960	3,235
3	2	10	1/2	3,820	3,580	3,700
4	2	25	1/8	3,110	3,550	3,330
5	2	45	1-16	3,840	1,230	4,035
6	3	10	1-16	3,300	3,370	3,335

[1] Test made at plant

[2] Time between initial mixing and sampling.

[3] Test made with truncated cone 12 inches high and with top and bottom diameters of 4 and 8 in., respectively.

[4] Tests made on 6-in. by 12-in. cylinder of 1:1½:3 concrete at age of 28 days.

after mixing. It became too dry for hand finishing, however, 45 minutes after mixing. Assuming that a wetter mixture would have segregated more easily, especially with a gravel aggregate, the experiment indicates that the most practical way to utilize the central mixing plant in concrete road construction is in connection with a machine finisher. It also indicates that so long as the concrete is workable after a period of hauling, the strength will not be affected.

The experiment was made simply in order to obtain some idea of the behavior of certain aggregates when handled as centrally-mixed concrete. It is the intention of the Bureau of Public Roads to make a somewhat extended investigation of this subject in the near future, using a variety of aggregates and consistencies.

Method of Constructing Modified Telford Base

As noted in our issue of Jan. 4, the Tennessee State Highway Department is now using a modified telford base in some of its highways. An interesting account of the methods of constructing this base is given by J. H. Thomas, in the January Tennessee Highways, a publication of the department. The notes following are taken from Mr. Thomas' article.

At the present time, the State Highway Department has under construction in Knox County a Federal Aid Project extending from the city limits of Knoxville to the Loudon County Line, the total length of the project being 15.6 miles. This construction is a link in the most important through highway in East Tennessee. The existing road was a 12-ft. macadam surface which had worn so roughly that it was almost impossible to ride over it in an automobile at a speed exceeding 10 miles per hour. In the design of the new highway it was decided to utilize as much of the existing macadam surface as it was possible to use without material to alignment and grades. It was therefore decided to scarify and reshape the existing macadam surface on 9½ miles of this project. In this way it was possible to obtain an extremely well compacted sub-base for the pavement. The graded width of roadway is 26 ft., exclusive of ditch lines, and the width of surface is 18 ft. All drainage structures are constructed of concrete. The type of base course specified is hand placed base course No. 1, consisting of large stone very carefully placed, and giving a total depth of 8 in. after compaction. This project is surfaced with Kentucky rock asphalt. Work started on the project about the middle of April and the construction of base course was begun about May 15.

The existing macadam surface is thoroughly scarified and roughly shaped with a road machine. The fine dressing of the sub-grade was then accomplished in the following manner: Line and grade stakes are set by the engineer in the center of the roadway, at the extreme outside edge of the roadway and at points intermediate between the center and the edge of the roadway. These stakes are usually set 50 ft. apart. Strings are then stretched from one stake to the other, forming fine lines between any 50 ft. Fine grading is then performed by hand, using picks and shovels. The result of this has been a perfectly uniform and compacted subgrade which consists of the existing macadam and which will probably average about 4 in. in depth. The character of subgrade is made uniform by spreading out the existing macadam to a width of 18 ft. The crown used is ⅓ in. per ft., or one-third of an inch per foot, the cross section of the subgrade being exactly parallel to the finished surface and forming the arc of a parabola.

After the subgrade has been prepared as outlined above the course stone forming the base is placed on the subgrade. Cylindrical blocks of wood 8½ in. in thickness are used to determine the thickness of base course. As a rule, two of these blocks are placed in line at right angles to the road and immediately other lines of blocks are placed about 5 ft. from the first line. In this manner it is possible to keep the thickness of base exactly uniform and parallel to the subgrade.

The stone composing the base is a very hard quality of red marble. These stones are placed with extreme care so as to secure the maximum bearing power and to leave the minimum of voids between the large stones. As a rule, the stones are selected and placed so that each stone extends entirely from the subgrade to the top of the base. The use of very large stone is prohibited. After placing the main stone, quarry spalls and other wedge-shaped angular rock are dropped by hand vertically into the voids between the main stones, these spalls forming ideal wedges. Care is also exercised to place the main stone as nearly vertical as possible, and as nearly at right angles to the direction of the center line of the road as possible.

After placing and wedging the voids, the surface of the base is napped so as to break up any angular points which project above the general level. However, not a great deal of work is required in napping the base, because of the uniformity of the stone, and great care exercised in placing them. After napping, the surface of the base is thoroughly rolled with a 10-ton roller until all stone is thoroughly compacted and wedged.

The contractor has found it advisable after shaping his subgrade to haul this stone and dump it directly upon this subgrade for a distance ranging from ½ mile to 1 mile from the place where he is laying base. He has generally kept from four to six gangs laying base, these being placed at intervals of about 75 ft. He has generally used about four men to each gang placing stone and the average rate of placing has been about 75 lin. ft. per day for each gang of four men.

After thorough rolling, the voids in the main stone composing the base course are filled with screenings. Pure screenings were used as a filler; that is, only material passing through a ¾-in. circular opening and including dust. These screenings are applied carefully, broomed into the voids by hand and the surface again rolled, the application of screenings, brooming, and rolling continuing at the same time until all voids are filled.

After all the voids in the main stone have been filled as previously outlined a smoothing layer of stone is spread to a uniform depths of 2 in. over the base course which has been constructed. This stone consists of material passed over a ¾-in. circular opening and through a 2½-in. circular opening. This material is spread very carefully and in such a manner that the finished surface is perfectly uniform, free from all depressions and waves, and exactly parallel to the finished surface. A definite thickness of stone was used in all cases. After spreading this stone and just previous to the spreading of rock asphalt this smoothing layer is lightly rolled, just sufficiently to thoroughly set the stone into the base course and to smooth the surface and not sufficiently to materially crush the stone composing this layer.

No Politics in Road Construction in Ontario

Addressing the past presidents and directors of the American Road Builders' Association, who were entertained at dinner by Lt. Col. H. L. Bowlby, president of the organization, at the recent convention, F. C. Biggs, Minister of Public Works for the Province of Ontario, Canada, declared that road building in his province is divorced entirely from politics.

"We have 57,000 miles of road all told in Ontario," he said. "We propose to spend $25,000,000 on new roads this year. We have 2,000 miles of improved roads now under maintenance. The Dominion Government pays 40 per cent of the maintenance; the Province of Ontario 40 per cent, and the municipalities 20 per cent. In municipalities of less than 750 population, our roads are built through the municipality without cost to the town. If the town is above 750 in population, the Province pays 40 per cent of the central 20-ft. width.

"Politics is not known in road construction in Ontario. We have no commission to blame for anything. The Minister of Public Works is responsible to the people from the floor of parliament. Our people are not favorable to commissions. If the Minister of Public Works does not make good, he finds after the next election that somebody else has his job.

"All of the bridge construction in Ontario of whatever nature, whether the bridge be 10 ft. long or 1,000 ft. long, is done by my department. We have a staff of 65 engineers, all of whom are directly responsible to the head of the department. Of this staff 97 per cent served with the Canadian forces in Flanders or France. We are rather proud of our part in that."

Recent Developments in the Highway Field

Abstracts of Papers Presented Before the Good Roads Congress Held at Chicago Jan. 16-20 by the American Road Builders Association

Highway Research

By W. K. HATT,

Director Advisory Board on Highway Research, National Research Council, Washington, D. C.

The proportion of the national wealth available for the purposes of transportation is limited. This proportion must be distributed among the various agencies, railroads, highways, etc. Inasmuch as the money spent on one agency is not available for another, it is clear that highway transport is intimately bound up with transportation in general. At present we see but dimly this new form of transportation, highway transport, which has come upon us in the past 15 years. No man can think wisely, and no legislation can be properly based, until the date of economies of highway transport are assembled and analyzed.

That part of the national wealth devoted to highways should represent capital invested, earning dividends, and not capital consumed. Therefore, the location and type of road, should be based upon the traffic, present and future, the climatic conditions, the foundation and available materials. In other words, the economic balance between capital cost and operating expense should be maintained. The highway should be designed, as an engineer designs anything else, to fit the conditions. There is no nostrum.

But when we speak of operating costs, where are the data? Who knows the maintenance costs of various types, properly allocated to surface, shoulders, ditches, etc., and the replacement cost; and the traffic that reflects itself in these costs? And who knows the operating costs of the vehicle arising from roads of various grades, lengths and surfaces? Since somewhere near $12 are spent on the vehicle where $1 is spent on the road, the survey of the situation should not be confined to the road.

And who should pay the cost of highways, the user alone, or property and user? What part of the cost should be met by bonds and what part by current funds?

We have been so busy buying shoes for our rapidly increasing family, that we have not had time to sit down and work out the budget.

Now it is clear that highway development in the future must depend upon a more critical economic analyses than in the past; and the highway transport officials must prepare their case. The data of economics of transport must be gathered as rapidly as possible.

On the engineering side we have made rapid progress, studying materials, strength of road slabs to carry loads over various conditions of subgrade. So that when the legislators tell the engineer what maximum load he is to provide for, a fairly consistent design will be forthcoming. But will the legislator decide this question arbitrarily?

The Advisory Board on Highway Research of the National Research Council, has its sleeves rolled up, and is on the job. Its job is to draw up a comprehensive program of highway research, to make use of the research agencies in this field of research, and to collect and distribute the information that will allow a wise judgment upon these questions.

Single Track Concrete Roads for the Average County

By P. C. McARDLE,

Former Superintending Engineer, Vermilion County, Illinois

In substantially all counties there is a growing demand for inter-communicating roads within each county to supplement the great through routes provided by the state and national government, and the people are not satisfied with gravel or macadam roads heretofore largely constructed by townships and road districts. Few of the states have any considerable mileage of double track hard surfaced roads already constructed so that for a long time the state and federal appropriations will be required for through route state and federal aid roads—the burden then must fall on the counties, the townships, or road districts for the remainder. Illinois has placed the responsibility of maintenance of state aid roads not yet constructed upon the county, but provides a method whereby counties may construct state aid roads through bond issues, and still at some future time receive the benefit of state aid; while the state accepts the obligation of maintenance after construction if such construction is carried on under plans, specifications, estimates of cost and contracts approved by the state and under its supervision. It is certain that under present circumstances counties are unable financially to construct any considerable mileage of double track roads, but could in part satisfy the demand by building single track roads.

Vermilion County, Illinois, in 1916 designed and has since then completed a system, 210 miles of single track paved roads, of which 170 miles was constructed by the county itself, 30 miles by townships forming connecting links, and 10 miles by the state. This system reaches into every section of the county, connecting every town with the county seat, and with each other. A considerable accomplishment for a county with a population of 80,000, and an assessed valuation of $62,000,000. Outside of one north and south (Dixie Highway) and one east and west road, the balance of the system serves every need, and will for many years to come, but the two through routes, though standing the traffic very well, must sooner or later be widened to double track roads. Part of the Dixie Highway, for five miles, was widened in 1920 by the state by adding an 8-ft. section to the already 10-ft. section, thus widening it to 18 ft., with very satisfactory results. All of the single track roads built by the county had gravel or macadam shoulders constructed on each side of the 10-ft. slab. Of these roads 140 miles were 10-ft. concrete, and 30 miles were 10-ft. monolithic brick roads. The state constructed originally 10 miles brick road on concrete base, of which somewhat over a mile was double track, of the remainder 3 miles had macadam shoulders, and 5 miles without shoulders. This latter was widened to 18 ft. All of these roads have been given satisfactory service.

If a county such as Vermilion County, Illinois, can financially construct so complete a system of roads that in part, at least, fill the need for hard surfaced roads, it follows that other counties similarly situated could do the same thing, and if a county with a population and assessed valuation such as Vermilion County could be considered an average county, then single track roads would furnish a method of satisfying the public demand for hard surfaced roads.

Utilizing Small Stream Valleys for Traffic Routes

By JAY DOWNER,

Chief Engineer, Bronx Parkway Commission, New York

The valleys of our larger streams are so commonly used for traffic routes that it is quite unnecessary to call attention to their advantages. This discussion is, therefore, limited to the protection and use of small stream valleys in the vicinity of centers of population. In the beginning we may as well face the fact that every small stream valley in or about a center of population is destined to be either a substantial asset or a definite liability to the city through which it extends. If it is taken in hand, protected and utilized, with marginal lands acquired by the municipality, it will usually afford excellent location for traffic routes, trunk sewer lines and parkways, which will substantially increase property values in its zone. While on the other hand, if left to shift for itself, unprotected, such a stream valley is almost certain to degenerate into a nuisance zone with distinctly depressing influence on property values and with the growth of population, presenting an increasingly difficult problem, which ultimately must be solved at a cost for abating the nuisance, which may easily be many times the cost of providing a parkway and important traffic route, if reasonable foresight had been exercised.

How the Bronx River Has Been Reclaimed.—As an illustration of the general problem, I will describe how a particular case—that of the Bronx River in and adjacent to the city of New York, has been reclaimed and utilized for what is destined to become one of the world's greatest pleasure traffic routes—the Bronx River Parkway.

The Bronx River Parkway Reservation extends for a distance of 15 miles, from the Botanical Gardens of Bronx Park in New York City, to the great Kensico Dam, four miles north of White Plains, the county seat of Westchester hills and emptying into Long Island Sound. It has a beautiful valley between ridges roughly parallel north and south. Bold and rocky in some places there are expanses of meadow land in other portions, in short, the diversity of scenery that Westchester County is noted for. The New York & Harlem R. R. closely follows this water course and with the development of towns and villages along this railroad, there came the inevitable sewage pollution and discharge of factory wastes. The Bronx River went from bad to worse year after year and served as a channel to convey the accumulated filth of the valley towns such as White Plains, Mount Vernon and the upper portion of Bronx Borough, into Bronx Park, through which the river flows and enlarges into several small lakes. Unfit for decent human habitation, the river banks in the towns were cluttered with stables, shacks and small factories, which with the stream itself formed an unsanitary nuisance affecting extended areas.

Investigations of the Bronx Project. More than 25 years ago, in 1895, the polluted condition of the Bronx River attracted sufficient attention to bring about the appointment by the governor of an investigating commission. This commission employed an engineer, who wisely recommended that the low lands along the river be acquired, not only to fully protect the river from pollution, but to provide ample width for a trunk sewer and important traffic route for Parkway Drive. The shortsightedness of those commissioners in refusing to adopt the recommendations of their engineer has cost the people of New York City and Westchester County many millions of dollars, for if the Parkway had been established at that time, the necessary lands could have been acquired at a mere fraction—certainly not more than one-fifth—of the present cost. This 1895 commission recommended instead that a sanitary trunk sewer be built parallel to the river. The question of enclosing the entire river in a big storm sewer was discussed, but discarded, it being impracticable to build a storm sewer large enough to carry the flood waters. That commission's recommendation to expend a large sum for the construction of a sanitary sewer did not appeal to the public imagination and nothing resulted therefrom.

Ten years elapsed and it became absolutely necessary from a sanitary standpoint to clean up the situation. Another investigating commission was appointed in 1906, which recommended that the most feasible solution, having regard for economy and return in public utility, was the creation of a Parkway Reservation, which would include the low lands and immediate slopes along either side of the river. The commission pointed out that this was the cheapest way to protect the river and that the land to be acquired would provide locations not only for sanitary sewer, but for a great parkway with traffic artery extending from New York City's park system 15 miles along the picturesque river to the magnificent Kensico Dam and Reservoir where the city owns 4,500 acres of beautiful woodland and lake areas. These recommendations were adopted as a joint project of New York City and Westchester County, and the legislative act provided for acquiring about 1,200 acres of land along the river, elimination of sewage pollution and development of a parkway.

Present Status of the Improvement. With the passing of time there had been a steady increase in land values in all suburban districts around New York City and lands in the Bronx River Valley, which could have been acquired a few years earlier at much lower cost, had so advanced that the 1,200 acres worth 25 years ago, perhaps, $1,500,000 to $2,000,000, are now costing, in spite of the utmost economy in acquisition, upward of $8,000,000. In the meantime, the natural beauty of certain sections of the valley had been almost totally destroyed and the restoration of these sections has added to the heavy cost of delay in starting the project. The Parkway Commission, however, made the best of the situation and as soon as the lands were acquired the nuisances were abated, garbage and refuse cleaned up, and over 170 cases of pollution were eliminated. With the river and reservation thus clean the commission found itself in 1916 with funds in hand for proceeding with the improvement program, the main feature of which was the construction of a Parkway Drive, 40 ft. in width, connecting the city's boulevards at Bronx Park with the magnificent system of state roads diverging from the northerly terminus of the new Parkway at Kensico Dam.

This 40-ft. driveway located in Parkway Reservation varying in width from 200 to 1,200 ft., with an average width of 600 ft., will provide an outlet for pleasure traffic of tremendous value to the great metropolis. The work of constructing the driveway is about one-half finished and the traffic on the sections already opened indicates that the driveway will be used to capacity when completed at the end of 1923.

Suggestions for Future Asphalt Specifications

By LEROY M. LAW,

Chief Chemist, New Orleans Refining Co., Inc.

Coming now to the matter of suggestions for future asphalt specifications, I shall take the liberty of approaching this phase of the subject from the standpoint of a refiner. Most engineers and contractors, however, have usually proven themselves to be open to suggestions from producing interests, consequently the following thoughts may be not amiss.

Perhaps the greatest desirability in future specifications is a more general simplification of requirements. The four provisions for penetration, ductility, loss on heating and flash point, together with, perhaps, solubility in carbon disuphide and carbon tetra-chloride, and softening point in the case of fillers, are serving the needs of many large cities and state highway departments and there is no good reason why they should not serve everywhere.

Methods of tests, preferably the above standards, should accompany all asphalt specifications or suitable references should be made therein so that the refiner will know not only what properties are desired but how they will be determined. As a matter of fact, methods of testing are as vital parts of specifications as the actual requirements yet in most cases this does not appear to be realized.

Another suggestion and one that I make with considerable delicacy—is that we should have just a little more competent inspection of deliveries, for the refineries are frequently the victims of inefficient and even careless testing. In this connection improper sampling, overheating of the specimen by too hasty melting and the use of contaminated containers have frequently been found responsible for discrepancies. Sampling as well as testing should, therefore, be conducted only by experienced persons. Refinery laboratories are equipped with the latest improved apparatus and employ high grade technical operatives. While occasional errors are, of course, possible with all human agencies, the chances for incorrect shipments are few under modern methods of refinery control.

The Narrow Limits for Consistency of Paving Asphalts.—Before closing this paper, I desire to call your attention to the narrow limits for consistency or "penetration" of paving asphalts which are now being ordered and ask your cooperation in remedying what has for some time been quite a troublesome matter. It is not by any means expected that we can accomplish at once a standardization in this respect for certain engineers have more or less fixed ideas regarding the subject and successful business necessarily requires that customers shall be satisfied. At the same time, however, we must look at the general situation. There are two reasons why asphalt penetration limitations should not be unduly restricted and, in view of the fact that they are not generally understood, these reasons are presented more or less in detail.

In the first place, although the penetration test itself has now become fairly well standardized as stated, it is by no means a test of great precision as some are disposed to consider it. A three-point difference between two operators working in the same laboratory is quite permissible as being within the limit of experimental error and, since such a difference may be in either direction a six point permissible range is thus justified.

Under the circumstances a specification allowing a two point range actually restricts the refinery to four points or degrees in penetration which is perhaps sufficient but only so under the most rigid control of manufacturing conditions.

For similar reasons five-point limitations are manifestly severe and only possible to comply with where both the seller's and purchaser's laboratories work to a degree of precision that is not warranted by the accuracy of the test itself. Furthermore, orders calling for definite consistencies such as "50 penetration asphalt," "60 penetration asphalt," etc., obviously do not allow even for the experimental error of the laboratory and are practically impossible to fulfill.

Reduction in Number of Varieties Desirable.—In the second place, narrow penetration limits have come to mean a multiplicity of products which in turn involve much unnecessary elaboration of refinery equipment. We cannot economically run our plants like the pickle factories and we should be permitted to discontinue a few of our varieties. If not, the refiner must either elaborate equipment or be continually changing his operating conditions with a resulting loss in plant capacity. These conditions are reflected either in increased manufacturing cost or delayed shipments—sometimes both with no benefit other than the satisfaction of an exaggerated idea of accuracy. We do not believe that many engineers will contribute to such conditions once the facts are fully explained.

In line with the foregoing statement, some refineries are endeavoring to standardize their paving asphalts as far as possible and, at the same time, take care of the well established types of construction. Under such an arrangement reasonable quantities of several grades such as 40-50, 50-60, 60-70 penetration, etc., could be kept in stock available for prompt shipment.

This policy is entirely in line with specifications of the United States Bureau of Public Roads and many cities and municipalities. It is also in accord with the recent action of the American Society for Testing Materials which, in proposing six "classes" of asphalts for paving purposes, allows similar penetration limits. Many purchasers, we are glad to say, are already in harmony with such arrangements but a small minority prevents them from realizing the full advantages

Paving Widths for Highways Serving Large Cities

By WILLIAM F. CAVANAUGH,
County Highway Commissioner, Milwaukee, Wis.

According to the goverment census of 1920, we have in the United States today 12 cities with a population in excess of 500,000 people and 56 cities with a population between 100,000 and 500,000.

A large percentage of the more heavily populated cities today have hard surfaced highways radiating outward from their corporate limits that are entirely inadequate to handle traffic because of their narrowness.

This is not due to a lack of foresight in most cases on the part of highway engineers but due mainly to the fact that these communities are not in a position to finance the building of a highway to a greater width.

Considerations in Selecting Pavement Width.—In choosing the proper width to construct a new highway or to widen an old one it is sometimes quite difficult to determine what width is proper. We have to consider first of all the amount of traffic it takes before construction together with the expected increase it will afterwards be called upon to take. It may be that in succeeding years adjacent and parallel highways will be built and a certain portion of traffic will be diverted over them.

In starting construction at the limits of a city that part of the highway through the outlying districts often required a greater width than that further on, due to a greater traffic on account of conditions being similar to city conditions and being more heavily populated than portions of the highway further on.

In these communities it is well to take the future growth or expansion of the city into account and plan accordingly, adopting the proper alignment and grades so as to afterwards conform to the grades and alignment of future intersecting streets. Drainage structure should also be planned with this end in view.

In the event that a highway is to be paved 20 ft. wide with the intention of later increasing this width it is well to construct the 20-ft. width to conform to the center line of the right of way and not make the mistake that some communities have in building along the old roadbed high deflected here and there from the center line. The main idea of course in so doing was to cut down on the grading cost and obtain a more solid foundation. Afterwards when these territories build up and the traffic increases it becomes necessary to widen the roadbed and it cannot be uniformly widened on each side and the result is the proper crown cannot be obtained on the new road and there is not a uniform sidewalk space. Additional right of way has to be purchased.

Hazards of Narrow Highway.—An 18-ft. or 20-ft. highway is especially hazardous for pedestrians at night time where highways close to the city are not illuminated. Most states have regulations regarding automobile headlights but the lack of illumination has been the cause of a great many accidents where autoists have run into and injured or killed pedestrians. We have some of our highway in Milwaukee County illuminated and expect to continue this work each year. We are using ornamental concrete poles with the bracket light and the cables laid underground. Unless these lights are elevated to a height of at least 25 ft. there is a very noticeable glare on the eyes of the passing motorist.

Most of our 16-ft. roads today are inadequate, especially so when there is any amount of truck traffic and the major portion of our highways are being constructed 18 or 20 ft. wide. This width suffices to care for two lines of traffic. Some consideration should be given to the matter of constructing a 30-ft. width which does not provide for more than three lines of traffic. We often speed up to pass the car in front and doing so may frequently meet another driver doing the same thing coming towards us and the result is a head-on collision in the center. It almost seems that in providing increased widths we should provide for either two, four or six lines of traffic.

I believe the use of a curb is warranted on wider roadways as the fills do not have to be constructed as wide and the shoulder width can be cut down, especially through the cuts, doing away with ditching; the drainage structures do not have to be built as wide and less right of way is necessary. It is clearly not good engineering to provide either inadequate or extravagant widths and it is often the case that a pavement 3 or 4 ft. narrower than the one laid would serve all the purposes of the wider one or an additional 3 or 4 ft. to a pavement along a highway, especially with a car line, will provide for two extra lines of traffic. Pavements are expensive to lay and should therefore be only sufficient to provide for traffic needs during the life of the surfacing.

The blind acceptance of right of way widths, irrespective of the various uses to which streets are being put, is especially unwarranted in the outlying parts of the city where houses are just beginning to be built and where the widening of main lines of travel would be comparatively cheap.

Experience the world over teaches us that old highways must be widened when the opportunity arises, but a community without a definite plan or program lets these opportunities for widening pass by.

The Use of Local Mineral Aggregate in Bituminous Macadam Roads

W. A. WELCH,
General Manager and Chief Engineer, Palisades Interstate Park Commission.

The proper use of local mineral aggregate in bituminous road construction means great economy in these days of high transportation and labor costs. It is possible to build good bituminous macadam road surfaces with practically any stone or coarse gravel found in the United States, provided this aggregate is free from loam, dust and silt when used.

The Sub-Grade the Real Road.—The bituminous mixture is at best a wearing surface like the rails of a railroad and it must be thoroughly and properly supported by the subgrade or it will fail. The subgrade is the real road—it must be properly placed, thoroughly drained, well settled and compacted, and, on such a subgrade, a bituminous surface can be laid successfully with a mineral aggregate of comparatively low crushing strength, except on main trunk roads. It is, of course, very necessary to thoroughly bond this aggregate and keep it free from moisture, dirt and dust, for these are in my opinion, the greatest enemies of proper bonding.

A railway engineer establishes the size and weight of his rails in accordance with the weight and speed of his traffic. On main trunk lines, these rails are made heavy enough to carry the heavy fast traffic, in spite of minor defects in the subgrade, but on the branch lines and feeders, these rails are lighter for economy's sake. Experience has taught these things and many others to the railway builder and the highway engineer should profit by these years of experience and experiment, for our highways have become very like our railways. Your main trunk lines should have wearing surfaces which will carry any traffic and any speed, without failure, in spite of minor defects in the subgrade, but such surfaces are not necessary on minor roads and it is not economy to build them.

Rock for Bituminous Macadam Road Surfaces.—The safe crushing strength of trap rock or basalt averages approximately 350 tons per square foot, of the granites 350 tons per square foot, of the limestones and marbles 300 tons per square foot, of good air cooled slag 300 tons per square foot, of the sandstones 215 tons per square foot, and ordinary chalk 15 tons to the square foot.

Practically all the stone in this country comes within these limits and all of it save the chalk and very soft sandstones will make good bituminous macadam road surfaces. Specifications must vary with the types. The softer aggregates must be used in larger sizes, greater care exercised with them to keep out the dust and the rolling must be governed by the type of aggregate. The harder stone can be thoroughly compacted by heavy rollers and still penetrated and thoroughly bonded by the asphalt or tar, but the softer stones, when used in penetration work, must not be rolled as hard or they will not allow the binder to properly fill the voids, and care must be taken to keep the aggregate even, as many quarries have seams or stratas of soft shaley stone, which, if put in with the better material, will cause trouble.

More care must be taken with the top course or seal coat when the softer aggregates are used to insure a thorough coating on the actual wearing surface.

Causes of Failure of Bituminous Macadam.—There is little accurate data obtainable on this subject, for few experimental sections of such surfaces have been laid and watched. Of all the failures of bituminous macadam surfaces, which have come to my notice, none have been due, in any way, to the character of the mineral aggregates. By far, the greater number of these failures are due to bad subgrade and the others to poor workmanship, dirt and dust in the aggregate or poor bonding, due to improper rolling and penetration. Many of these failures are due to frost action in the subgrade, or improper drainage, which permits this frost to heave up the surface, or the gradual accumulation of moisture in poorly drained places in the subgrade, which destroys the support of the wearing surface through no fault of that surface.

Other failures were plainly due to improper mixing or penetration, from careless workmanship; others to the careless use of dirty aggregate, so full of loam, silt or dust that the binder was not able to reach the stone, or the aggregate was badly graded. And some other failures are entirely due to bad or improperly heated binder. One sheet asphalt failure was due to the use of glazial silt, ground as fine as cement, as the only aggregate.

Examples of Bituminous Macadam Construction.—I know of one piece of penetration surface in which three experimental sections were laid, each of about 500 ft. In these sections were used trap rock, or very hard basalt, limestone, just an average grade and sandstone of good character, while, on all the rest of the road, granite of good grade was used. The surface was laid in three layers of 2 in., 2 in. and 1 in. Two years after opening, a seal coat was put on and nothing has been done with it in the past six years. The same material was used in the seal coat and I can distinguish no difference at all in these four sections of pavement. This road has carried up to 100,000 cars and trucks per season of eight months and the pavement is in perfect condition, but it is built on perfect subgrade and is well drained.

Between the entrance of a ferry slip and the end of a 1½-mile grade fill, brick paved on concrete base, with grades from [illegible] to 5 per cent, there is a piece 300 ft. long. As this fill was expected to settle, it was decided to lay a temporary cinder surface on it. Three inches of clean steam cinders were spread and rolled with a 10,000-lb. roller and 1 gal. per yard of bituminous binder was applied and lightly covered with more cinders. Two years later another application of ½ gal. per yard of binder was made and lightly covered with cinders, at the end of another two years, this 300 ft. of temporary surface is in perfect condition and more than 330,000 cars and trucks used it during the last eight months, and, yet, the crushing strength of cinders is not great.

In Eastern Ohio and Western Pennsylvania, much slag has been used and when treated about like limestone has made good surfaces. Many surfaces have been laid with crushed gravel, which is, of course, just like good crushed stone, if properly screened and washed before crushing. The usual specifications for this aggregate are 60 per cent or more of material to have angular fragments.

But some surfaces have been laid with gravel without crushing, and when this aggregate was clean, properly sized and bonded, these surfaces have been good. In Massachusetts and other New England states, this uncrushed gravel aggregate has been extensively used in the so-called "Tar Concrete Pavements" with success when the workmanship was good, and many old gravel roads have been successfully surfaced with only gravel aggregate.

Good workmanship means more in bituminous macadam surfaces than mineral aggregate does.

It would seem much wiser for the engineer to carefully study all available local mineral aggregate and prepare his specifications to permit the greatest possible use of it in his surfaces, than to fall into the easier method of copying standard specifications and so compelling contractors to import these aggregates and so greatly increase costs.

Better put this extra money in your subgrade work, for that is really your road.

The Bates Experimental Road of Illinois Highway Department

By CLIFFORD OLDER,

Chief Highway Engineer, Illinois Department of Public Works.

With the large amount of money for road construction that had been made available by the passage of the $60,000,000 road bond issue act, it was considered of extreme importance that "guess work" be eliminated from pavement design. With this in mind the construction of an experimental road near Springfield was undertaken. This is known as the Bates Experimental Road. It was started in 1920 and finished during the summer of 1921. The work of completion, and the subsequent investigations which have taken place, and which will be supplemented by running trucks over the road next spring, was heartily endorsed by Governor Small.

The Bates Road is about two miles in length, and includes 63 sections each approximately 200 ft. long and representing all types of modern pavements; several thicknesses of each type being used so that when trucks are operated over the road with increasing loads, the capacity of each section, measured in terms of weight and numbers of trucks, will be plainly obvious.

Some Results of the Experiment.—Although the truck loading of this road has not yet taken place, the research work carried out by the department thus far indicates what may be expected of each type and each thickness. Already many matters of great interest to engineers and of vital importance to the tax payers and the road users, which have not heretofore been known, have been determined. For example. Heretofore it has been assumed that by means of tile drains, the foundation soil under a pavement may be kept dry. The Bates Road test shows that tile drains are practically useless as far as keeping the foundation soil dry is concerned, although they may prevent excessive "heaving" of the slab because of frost action. A surprising fact brought out was that the amount of water in the soil under a road slab may be as high as 40 per cent of the weight of the dry soil, and this in spite of the fact that tile drains may be placed along each edge of the pavement. Rigid pavements, such as concrete and brick on a concrete base, are not fixed and rigid as the casual observer commonly believes; but are in constant motion even though no wagons or trucks may be moved over them. Such pavements lengthen and shorten due to changes in temperature; they stretch and shrink laterally due to the same causes. More important to the engineer, however, is the fact discovered by the Illinois Division of Highways that the unequal beating and cooling of the top as compared with the bottom surface of the pavement as the temperature of the air changes, causes the pavement slab to curl up at the edges at night to such an extent as to lift the edges entirely off the foundation soil. In the day time the reverse is true, when the center of the pavement is likely to be lifted entirely free from the foundation. The importance of this action may be appreciated when it is known that the edge of a concrete slab 7 in. thick may lift above the foundation in extreme cases as much as ¼ in. at night. Obviously, pavement slabs must be designated for this condition.

As a result of these investigations, it is believed that Illinois has been enabled to design pavements having practically double the strength of the designs heretofore used, and yet at a saving in cost of approximately $1,500 per mile.

Another matter of interest brought out relates to the breaking down of concrete slabs under repeated loads, due to a fatigue of the slab. This may be better understood by an illustration. The Department has found that a truck wheel carrying a total weight of about 5 tons may pass along the edge of a 7-in. concrete pavement of the ordinary design once or twice without breaking the pavement; yet if the same wheel passed along the edge from 10 to 50 times, the edge of the pavement breaks down in many places. Loads on such a pavement would have to be reduced to 2½ tons in order that trucks having wheel loads of this magnitude might be carried indefinitely by the pavement. Further, investigations have shown that a pavement may carry loads equal to 60 or 70 per cent of the critical loads only a few thousand times without breaking—in other words, in order to provide a reasonable factor of safety a pavement must not be loaded in excess of one-third of its apparent strength without danger of its failing in a comparatively short time.

Although the construction of the Bates road has involved a considerable expenditure of state funds this fund has already been returned many times in reduced construction costs and the knowledge gained as regards the construction of better roads. While the saving effected in the expenditure of the $60,000,000 road fund will amount to a considerable sum because of the Bates experiment, yet this item is of far less importance than the saving of maintenance expense effected by the construction of the best pavements engineering ingenuity can devise.

Uniform Legislation as Affecting Highway Traffic and Highway Transport

By D. C. FENNER,

Manager, Public Works Department, International Motor Co.

Any discussion and understanding of uniform legislation as affecting highway traffic and highway transport must be based upon a thorough knowledge of the political structure of the governmental units in which highway traffic and highway transport prevail. This observation seems almost axiomatic and perhaps superfluous, yet too often in voicing the desirability and need for uniform motor vehicle legislation we overlook the fact that motor vehicles in their operation pass through the border lines of and come in turn, under the jurisdiction of municipalities, counties and states.

As for municipal control over highway traffic and highway transport, the kind and degree of such control is dependent either upon the constitutional rights which any state may give to its municipalities, or else upon the laws which states have enacted delegating more or less of their own power on the subject to some or all such municipalities.

While it is true that as a general rule the municipalities may not enact ordinances regulating highway traffic and highway transport along lines in conflict with the provisions of the general state motor vehicle laws, nevertheless, there are numerous important exceptions to this rule. Then, too, there are matters such as the regulation of motor vehicle operation in front of schools, churches, etc., which are matters of local concern and are usually left to the municipalities for regulation.

State Legislatures Have Ultimate Control of Highway Transport.—By a process of elimination, therefore, we arrive at the fact that under present conditions ultimate control in the matter of legislation governing highway traffic and highway transport lies in the legislatures of our various states. It is to these state legislatures, therefore, that in last analysis we must look for that vital and important end—namely, uniformity of motor vehicle laws and uniformity of enforcement.

Uniform legislation does not mean, necessarily, that all states should adopt one and the same law, identical in all their provisions. This might be considered the ideal condition, but from a practical standpoint, it is not necessary.

What is needed, however, is uniformity in those sections of the state laws that deal with definition of terms, traffic regulations, hand signals, qualifications for drivers, size and weight restrictions, obligatory equipment of a vehicle, headlight laws, the denominations and disposition of license fees.

Let us take a specific instance to illustrate this point: From the standpoint of the trucking business, which is today assuming very large proportions, no factor is more important than that the various states and their political subdivisions should impose one and the same set of rules and regulations governing the weight limits which such trucks are allowed to carry. A very encouraging procedure in the states of Connecticut and New Jersey restricts the load upon a motor truck to the manufacturer's rated capacity of the vehicle. As the enforcement of this provision will absolutely prevent overloading, it gives the manufacturers a chance to co-operate with the state highway engineers in the design and proper rating of vehicles for the protection of the highways.

Wide Variation in State Vehicle Laws.—The standard specification of a motor truck chassis now contains the allowable gross weight of the chassis, body and load, and also the actual chassis weight. It is possible that these two weights will be the only ones stamped on the truck caution plate by the manufacturer, and that the actual weight of body and the resultant pay load capacity must be stamped on the plate by the owner of the truck before he can obtain his vehicle license plates. Similarly in the operation of passenger cars there are virtually as many laws on the subject of head lamps and head lighting as there are states in the Union, and no one starting out on a tour is able to be sure that perhaps at any momonet or at any place he will not be arrested and severely penalized for the breach of some law or regulation at variance with the ones of his own state with which he is familiar and whose observance has become a matter of habit.

This wide variation in state vehicle laws and the unsatisfactory conditions resulting therefrom are greatly aggravated when there are local ordinances additional to or at variance with those laid down in the state laws. Obviously, therefore, the economical operation of a motor vehicle, even within the confines of a state become more or less of a gamble.

The Remedy.—The remedy for these unsatisfactory conditions lies, of course, in uniformity of state laws having to do with the operation of motor vehicles and uniformity in county or other municipal ordinances. Furthermore, the local ordinances must in every respect conform to the general principles set forth in the uniform state laws. Several movements to accomplish this end have been begun, but the one which has attracted the most support and has gained the greatest headway is that which is now being sponsored and furthered by the Motor Vehicle Conference Committee, an organization composed of representatives from the American Automobile Association, Motor and Accessory Manufacturers' Association, National Automobile Chamber of Commerce, National Automobile Dealers' Association, Rubber Association of America, and the Trailer Association of America. Their views on the matter of uniform state legislation are set forth in a so-called proposed Uniform Motor Vehicle Law and Proposed Uniform Anti-Theft Law. To be sure, these measures contain many features to which persons have taken exception, and it is quite possible to point out sins of commission and omission in their provisions. Nevertheless, their recommendations reflect the views of able and experienced men in matters having to do with highway traffic and highway transport, and it is gratifying to know that many of the recommendations of these two proposed laws are finding their way, if not verbatim, at least in principle, into many of the laws of our various states.

More important, however, than this is the fact that the extensive and intensive work that has been done in advocating the proposed uniform vehicle law and proposed anti theft law have brought home to the public and their law makers the fact that the time has come when uniformity in the regulation of highway traffic and highway transport is absolutely necessary for the safety and convenience of vehicular and pedestrian traffic.

Sands for Sheet Asphalt Paving Mixtures

Selection and Proportioning by Triaxial Diagram Described in Paper Presented Before Good Roads Congress

By PREVOST HUBBARD,
Consulting Engineer, The Asphalt Association

Control of the character and grading of sand used in the preparation of wearing course mixtures is a very important factor in the construction of sheet asphalt pavements. Ordinarily sand constitutes from 70 to 80 per cent of the weight of such mixtures and under compression during construction the sand grains are crowded together so as to form the skeleton structure or frame work of the wearing course. These grains take most of the wear of traffic and should therefore be of hard sound material such as quartz. They should also be clean and free from coatings of any sort and preferably rough surfaced so that the asphalt cement will adhere firmly to them. With regard to the actual size and grading of the sand grains best suited for such work much more has been learned from experience than from theory. Theory and practice, however, agree on the desirability of using sand with a relatively low percentage of voids when the grains are in intimate contact. Experience has shown that when certain grading requirements are met the percentage of voids may be kept within satisfactory limits without sacrificing other necessary characteristics, such as ability to carry mineral filler. Such requirements are therefore usually included in specifications.

Grading of Sands for Sheet Asphalt.—The presence of an appreciable amount of grains coarser than 10 mesh brings the mixture into another class of construction known as asphaltic concrete which will not be considered in this article. Sand grains passing the 200 mesh sieve are considered undesirable because they tend to produce a mushy mixture and limestone dust or Portland cement are preferentially used to supply all of the very fine mineral matter which is necessary to fill the tiny voids in the sand aggregate. The first requirement is therefore that the sand shall all pass the 10 mesh sieve and the second that not more than 5 per cent shall pass the 200 mesh sieve. The first requirement can be met without difficulty even if the original product has some material larger than 10 mesh, by passing it over a revolving screen, with openings of suitable size, which is located over the storage bins of the paving plant. If the second requirement is met nearly all of the material passing a 200 mesh sieve will be blown out of the sand during its passage through the drier so that for all practical purposes the sand specified may actually be considered as all passing the 10 mesh and retained on the 200 mesh sieve.

Having quite definite maximum and minimum limits for the sand as a whole it is also most convenient in paving work to calculate the relative weights of the various size grains upon a percentage basis which will show a total of 100 per cent passing the 10 mesh and retained on the 200 mesh sieve. Eight standard sieves are used for this purpose, 10, 20, 30, 40, 50, 80, 100 and 200 mesh, and each percentage calculated represents a size which passes one sieve but is retained upon the next smaller sieve. There are therefore seven such individual sizes the allowable percentage limits of which are included in paving specifications. The following table shows the limits taken from Specifications of the Asphalt Association, which are typical of good practice:

SAND GRADING FOR SHEET ASPHALT

[illegible]	[illegible]	Per Cent Individual Sizes	Group Sizes
[illegible]	[illegible]	3 to 15	Coarse 14 to 50
[illegible]	[illegible]	3 to 15	
[illegible]	[illegible]	5 to 25	
[illegible]	[illegible]	5 to 40	Intermediate 30 to 60
[illegible]	[illegible]	5 to 30	
[illegible]	[illegible]	6 to 20	Fine 16 to 40
[illegible]	[illegible]	10 to 25	

The Three Group Method of Grading.—In this table it is seen that besides the limits for each individual size the sand grains are divided into three main groups which may be designated as coarse, intermediate and fine. The coarse group consisting of 10, 20 and 30 mesh particles all of which are retained on the 40 mesh sieve, is allowed to vary between 14 and 50 per cent. Taking an average of 32 per cent an approach toward the minimum limit is desirable for heavy traffic which tends to crush the large grains more readily than the fine. For relatively light traffic, however, a higher percentage of coarse grains is not only permissable but will produce a mixture less likely to crack by contraction owing to the thicker films of asphalt cement which it carries. Under heavy traffic any tendency to crack is largely overcome by the kneading action of the traffic itself.

The fine group, consisting of 80 and 100 mesh particles which are retained on the 200 mesh sieve, serves to fill the large voids in the combination of coarse and intermediate groups and enables the mixture to hold, evenly dispersed, the mineral filler which is needed to fill the very small voids and give stability to the pavement. When the percentage of coarse group is relatively high the percentage of fine may be relatively low and vice versa.

The intermediate group, consisting of 40 and 50 mesh particles which are retained on the 80 mesh sieve appears to serve somewhat as a pivot for the coarse and fine groups. An average of about 45 per cent will serve equally well for use in light and heavy traffic mixes. In the former, however, the sand may carry as high as 60 per cent and the latter as low as 30 per cent of the intermediate group.

When the fact that a certain amount of each individual size is specified it is seen that the percentage limits for each size are quite broad. As a matter of fact if in each group the individual sizes are about equally proportioned a very satisfactory grading results. The group percentages are therefore the most important and are first considered when selecting sand for sheet asphalt construction.

The use of local sand for paving work is desirable not only from the standpoint of convenience but as a matter of economy. As has been stated sand constitutes from 70 to 80 per cent by weight of the paving mixture and a high freight rate on this constituent greatly affects the cost of the finished pavement. It frequently happens, however, that no single local sand can be found which meets specification requirements and when this happens it may become necessary to mix or combine two or more available sands of known mesh composition in order to produce an acceptable product. In such case it becomes necessary to ascertain in what proportions the sands should be used to give the desired grading. This is ordinarily done by a tryout method or by a lengthy but simple mathematical calculation. The fact that there are three main groups to be considered and that the sum of these groups equals 100 per cent makes it possible to utilize the triaxial diagram for quickly and accurately ascertaining the most suitable proportions, although to the best of the writer's knowledge the diagram has not heretofore been used for this purpose.

The Triaxial Diagram.—For those who are not familiar with the triaxial diagram it may be said that it consists essentially of an isosceles triangle in which, as is well known, the perpendicular distance from each base to its opposite apex is equal. These perpendicular distances may therefore serve to represent 100 per cent of anything that the base lines stand for. The perpendicular distances may be divided in any convenient way such as hundredths and if lines are drawn through such divisions parallel to the base lines the large triangle is divided into a large number of small isosceles triangles as shown in the accompanying illustrations. It is a simple geometrical proposition to prove that for any point within the area of an isosceles triangle, the sum of the perpendicular distances to each side is equal to the perpendicular distance from any side to its opposite apex. If the distance from base to apex represents 100 per cent it is evident that the sum of the perpendicular distances from a point within the triangle to each side must also equal 100 per cent. When there are only three constituents of a substance it therefore becomes possible to plot the percentage composition of each constituent by means of a properly located point within the triangle.

In Fig. 1 each side of the large triangle serves as a base line for one of the three groups of sand grains previously discussed. The distance between each side and its opposite apex is divided into 50 equal spaces by lines parallel to the base line and the distance between each line and its neighbor therefore represents 2 per cent. Within the area of the triangle the two dots surrounded by circles represent the composition of ideal sands for light and heavy traffic which conform to the following grading in so far as the three group sizes are concerned:

Passing	Light Traffic Per Cent.	Heavy Traffic Per Cent.
10, 20, 30 mesh	[illegible]	23
40, 50 mesh	[illegible]	43
80, 100 mesh	[illegible]	34

The dotted lines connecting the light traffic sand with the three sides of the triangle illustrate how the position of the sand has been located to show the percentage composition given above.

Figure 2 is exactly the same as Fig. 1 except that the dotted lines have been left out and a shaded area inserted to represent the percentage limitations for the three groups as covered by the specification requirements given in the first table. It is at once evident that any sand which conforms with the specification limits will fall within this shaded area if its percentage composition is plotted. On the other hand if the sand lies outside of the shaded area it does not conform with the specifications and should only be used in combination with some other sand.

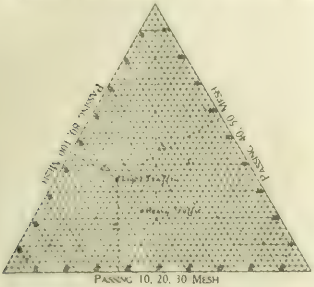


Fig. 1.

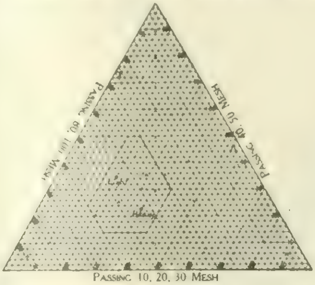


Fig. 2.

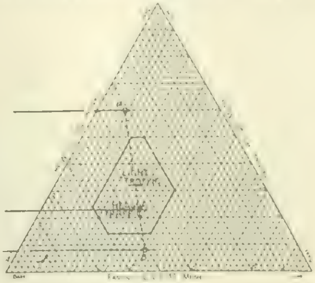


Fig. 3.

Problem I—Use of the Triaxial Diagram in Proportioning Two Sands.—Suppose two sands, a and b are available neither of which meet specification requirements and it is desired to ascertain if these sands may be combined so as to conform with specifications and if so the most suitable proportions in which they should be combined. For the sake of illustration it may be assumed that these sands show the following grading:

Group	Per Cent. a	Per Cent. b
Passing 10, 20, 30 mesh	60	8
Passing 40, 50 mesh	31	51
Passing 80, 100 mesh	9	41
Total	100	100

If these two sands are plotted on the diagram it is found that their location as shown by points a and b respectively in Fig. 3 lie outside of the specification area. The grading of all possible combinations of these two sands is then illustrated by means of a straight line drawn between these two points. If their locations had been such that the connecting line did not cut the specification area it would have been impossible to combine them in any proportions so as to meet specification requirements. In the example given, however, it is seen that the connecting line passes through the specification area and that a rather wide range of combinations will prove satisfactory. It is therefore possible to so proportion the sands as to obtain a grading at any point on the connecting line within the specification area. If, for example, it is desired to produce a grading as close as possible to the ideal heavy traffic sand the location of such grading would be indicated on the diagram at point "c," the actual grading of this combination being as follows:

Passing 10, 20, 30 mesh	23 per cent
Passing 40, 50 mesh	45 per cent
Passing 80, 100 mesh	32 per cent
	100

The proportions required to produce this grading are, moreover, directly indicated by the relative distance of point c to points a and b. Thus if the distance from c to a is twice the distance from c to b then two parts of sand b to one part of sand a will give the grading shown by point c. The exact proportions may be quickly and conveniently ascertained by first drawing parallel lines through the points a, b and c. In doing this any convenient base line of the diagram may be used as a guide. In Fig. 3 the 10, 20, 30 mesh base line has been used for this purpose but either of the other base lines would have served equally as well although it is desirable to have the parallel lines as far apart as practicable. As the lines which were drawn are parallel it follows that the relative distances between them are exactly the same as the relative distances between points a, b and c through which they pass. These lines may therefore be used equally well to determine exact proportions.

If we now forget the diagram itself it will be found that four lines have been plotted as shown in Fig. 4. By means of a special proportional parts measure also shown in the figure it becomes possible to read off at once the exact proportions in which sands a and b should be combined to produce the grading represented by c. It will be noted that the two end divisions on this measure are lettered A and B respectively. In using the measure division A should first be placed at any suitable place on the solid line passing through point a and then rotated until division B rests on the solid line passing through point b. It is seen that the solid line passing through point c intersects the measure at a division which shows the proportional parts in columns A and B to be 7 and 17 respectively. In other words 7 parts of sand a and 17 parts of sand b will give the grading of the combination represented by point c.

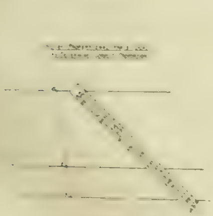


Fig. 4.

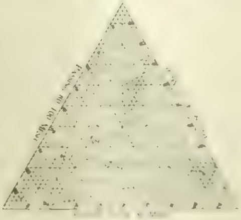


Fig. 5.

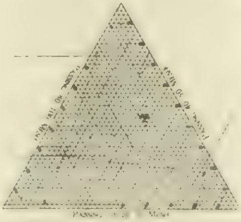


Fig. 6.

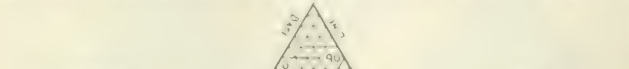
Fig. 7.

Problem II—Use of the Triaxial Diagram in Proportioning Three Sands.—If the use of the triaxial diagram for proportioning two sands is thoroughly understood its use in proportioning three sands becomes a very simple matter. In the following example it will therefore be assumed that the reader has mastered Problem I:

Suppose three sands, a, b and b' are available no two of which can be combined to meet specification requirements, and it is desired to ascertain if the three sands may be combined so as to conform with specifications and if so the most suitable proportions to use. As an illustration it may be assumed that these sands show the following grading:

	Per Cent		
	a	b	b'
[illegible]	[illegible]	[illegible]	18
[illegible]	[illegible]	80	8
[illegible]	[illegible]	18	74
Total	..100	100	100

The location of these three sands in the triaxial diagram is shown at points a, b and b' in Fig. 5. It is seen that none of the lines connecting these points pass through the specification area so that no two sands can be combined so as to meet the specifications. By combining sands a and b, however, any grading may be obtained on line ab and if all such possible mixtures of a and b are considered it is further seen that sand b' may be combined with such mixtures so as to produce all gradings falling within triangle abb'. As the specification area falls within this triangle it is therefore possible to combine the three sands so as to obtain any desired grading within the specification area.



Methods for Determining Proportions of Sands for Sheet Asphalt.

The above diagram may be used to work out actual sand proportioning problems. The sand gradings and the ruling of necessary lines may best be plotted and drawn upon a transparent paper placed over the diagram. This makes it possible to use the same diagram for the solution of any number of problems.

Now suppose it is desired to obtain the ideal heavy traffic grading in the specification area we may draw a line from point b' through the ideal heavy traffic grading and continue it until it intersects line ab. The point of intersection may be lettered c. The determination of the proportions of sands a and b to produce c may be readily determined as described under Problem I and if this mixture is then considered as a single product the proportions of this mixture with sand b' which will give the ideal heavy traffic mixture may be determined in a similar manner.

Figure 6 illustrates the preliminary steps necessary to determine these proportions with one set of parallel lines drawn through points a, b and c and second set of parallel lines drawn through c, b' and the ideal grading. Fig. 7 shows these parallel lines with the diagram eliminated the lines being lettered (a), (b), (c), (a'), (b') and (c'). Now suppose the proportional parts measure shows that one part of a and 2 parts of b will produce c. Further suppose it is found by using the measure that 2 parts of this mixture now called sand a' and one part of sand b' will give the ideal grading now called c'. The exact proportions of sands a, b and b' would be obtained by multiplying the parts of a and b by the parts of a' and multiplying the parts of b' by the sum of the parts of a and b, as follows:

Parts				Direct Proportions
a	1	a'	2	a 1 × 2 = 2
b	2			b 2 × 2 = 4
Total	3	b'	1	b' 3 × 1 = 3
				Total 9

The Proportional Parts Measure.—For use with the triaxial diagram a proportional parts measure may be devised with any convenient scale of divisions. For most purposes the a scale showing all common proportions not exceeding a total of 12 parts to the mixture will be satisfactory. For the sake of convenience when actually mixing sands it is desirable to have as few total parts as possible and it will often be found that without creating much change in the grading of a mixture one set of proportions may be as good as another. In such cases the simplest proportions should be selected. Thus in Fig. 4 while the exact proportions of sands a and b are shown as 7 to 17 respectively it is seen that the more simple proportions of 1 to 2 or 1 to 3 are quite close. Reference to Fig. 3 will further show that either of these simple proportions is sufficiently close to the desired grading to be adopted as a matter of convenience.

It should always be remembered that the triaxial diagram takes into account only the three sand groups and that the intermediate gradings are also covered in specifications. After it has been used therefore the individual gradings should be calculated on the basis of the proportions which have been indicated in order to ascertain if such proportions will be entirely satisfactory. If not a slight change in indicated proportions will often be found to bring the mixture within specification limits in all respects. Of course, if any individual size is missing in all of the sands the specifications cannot be met, but this would be a rare exception and in most cases the proportions determined from the group gradings alone will be found satisfactory.

Field and Plant Use of the Triaxial Diagram.—A triaxial diagram with a transparent cover of celluloid or tracing cloth which may be carried in an ordinary coat pocket will often prove a considerable time and labor saving device for the contractor, inspector and engineer both when prospecting for available sands and in setting proportion for use at the paving plant. The transparent cover may be used for plotting the sand gradings and drawing the lines for use with the proportional parts measure, and when one set of determinations has been made all marks may be erased and the cover used over and over again.

If when prospecting for sands a portable field outfit consisting of a small spring balance and set of four sieves (10, 40, 80 and 200 mesh) is used, the triaxial diagram will quickly show when suitable products have been located. To those who have not been familiar with the triaxial diagram, methods here described may at first seem somewhat complicated but with very little practice it will soon be found that its use is a very simple matter and much less tedious and complicated than any method of mathematical computation.

New Jersey State Highway Convention.—Plans have practically been completed for the Second Annual State Highway Convention to be held Feb. 15 to Feb. 18, inclusive. The convention sessions will be held in the assembly room of the new Stacy-Trent Hotel, at West State and Willow streets, Trenton, N. J. Reservations at the hotel may be made through the chairman of the Arrangements Committee, A. Lee Grover, P. O. Box 27, Trenton, N. J. The convention program will begin at 10 a. m. and 2 p. m. Instructive and enlightening papers will be submitted, and active discussions held on all phases of road construction. Moving pictures of actual road conditions will be shown at the end of the days' sessions. A cordial invitation is extended to all county and municipal officers, contractors, materialmen, equipment dealers and manufacturers, to attend all sessions of the convention.

Cost Keeping on Highway Construction

Advantages and General Principles Described in Paper Presented Jan. 20, Before Good Roads Congress

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Assistant Chief of Construction U. S. Bureau of Public Roads

From an extensive investigation made about six years ago by the U. S. Bureau of Public Roads it was found that generally very little cost keeping was done by state and county highway departments on highway work. Where practical and efficient cost keeping existed it was usually found to be on work done by the state highway departments. There was at that time very little interest manifested by public officials in cost keeping on highway work. A similar condition with respect to cost keeping existed to a large extent among road contractors. At this time there had been a long period of almost uniform conditions with respect to labor, materials, types of construction, and processes. The successful contractor had grown up in the business and had rules and methods of his own for estimating, which were based on years of experience, and he did not feel the need of cost statistics. The greater portion of the highway work of the time was done by the type of contractor referred to as having his hat for his office and his check book for his cost record of the job. The more substantial contracting organizations and especially those which did not confine their operations to road work exclusively, carried cost keeping records on their road work. As a rule highway engineers attempted to obtain the costs on contract work, but generally did not give sufficient attention to the details of cost keeping to obtain complete and reliable data.

Greatly Increased Interest in Cost Keeping.—It has developed from a recent preliminary study of highway cost keeping conditions that there has been a substantial improvement since the investigations previously referred to were made. Of recent years, due to a scarcity of contractors in the highway field, it has been necessary for states and counties to do a large amount of highway work with day labor forces and the value of cost keeping as a check on expenditures and as a guide to efficient management has led to the installation of cost keeping of some kind on this work. In addition to serving these ends much valuable cost data have been accumulated which form an important part of the fiscal records of the work and have also been used advantageously in placing other work under contract. The advantages of keeping cost on day labor work are generally recognized, but there are divergent views with respect to keeping costs on contract work. As a result it will be found that with one state highway department cost keeping on contract work is incidental to the inspection and the resident engineer or inspector is to considerable extent left to his own devices in this regard, while with another state highway department the cost keeping is one of the important functions of the residency and not considered a sideline by any means.

When the cost on contract work is considered advantageously the method followed is either to select the jobs which will supply the information desired or to cover the entire program and keep costs on all contracts. In either case there should be sufficient force available to handle the inspection and cost keeping properly. It will be difficult if not impossible to secure satisfactory results unless the inspectors or cost keepers receive specific instructions as to what they are to do, are supplied with standard recording and report forms, and their cost keeping supervised as well as their inspection work. It is not meant to infer that cost keeping is of the same importance as the inspection of the construction, but that if cost keeping is to be carried on at all it should have more than casual attention from the administrative authorities.

Advantages of Cost Keeping on Contract Work.—The advantages resulting from keeping costs on contract work are usually given as follows:

1. Valuable cost data are secured which may be used for estimating purposes.
2. The department has available necessary cost data for making settlement with contractor where unforeseen conditions are involved.
3. Engineers and inspectors receive training in use of cost data and making up of estimates.
4. Provides a means for checking cost of work which may lead to development of more economical designs and methods.
5. In some cases of assistance to the contractor who may not have an adequate cost system.

The Bureau of Public Roads has abandoned the practice of keeping costs on all of its contract jobs, but is instead keeping costs on all day work and on such contracts where it is thought the data will be advantageous to the bureau. It will prove advantageous to a state highway department to collect cost data on a number of representative contracts each year as a general check on the cost of its designs and also to determine the margin of profit contractors are getting.

Practically All Contractors Now Keeping Costs.—The increasing use of cost keeping by contractors is even more pronounced than in the case of the state and county organizations. This is due principally to the unsettled conditions during the past three years which have made estimating more difficult and rendered as practically useless many cost data and hypothetical rules used a few years ago. New construction methods, and especially those processes requiring a more extensive use of equipment, have also increased the need of cost keeping. Possibly the increasing number of engineers in the contracting field has had some effect in turning contractors to cost keeping. It will be found that highway contractors are now working individually and through their organizations for more systematic and businesslike methods in estimating work and in the keeping of construction costs. While no uniform method for keeping highway costs has as yet been suggested by contractors' organizations, practically all contractors are now keeping costs on their work. Some of the systems used are almost of the check book class in simplicity, but they vary from this to a codified system of accounts divided and subdivided to collect cost of labor, materials, equipment and supervision on various operations. It appears that the present tendency is for highway contractors to develop cost keeping systems comparable with those in use by the building industry.

The Uses of Cost Data.—The primary purpose of cost keeping is to ascertain the actual cost of production. Not what the cost should be but what it is. For a contractor's use the cost system should furnish reliable data on current costs. In this way a periodic check on the cost of the work, which is an indication of the efficiency of the organization, is available as a managerial aid to the contractor or his superintendent. This function of a cost system is of especial value on highway work where there are usually a number of operations under way simultaneously on different parts of the job and in consequence all of the workmen are not continuously under the observation of the superintendent. Next in the importance to the contractor is the value of cost data as a guide for estimating future work. The increasing complexity of highway construction is making cost keeping of more importance. The large sums of money now involved in road contracts mean more items of work, new processes, and additional operations over former requirements. To estimate the cost involved without comparable cost data is becoming too costly a hazard. It is not enough to know that there was a net profit on the job. But in order to use the data for estimating purposes it must be known by items and operations the actual cost of production.

In the construction industry it is not practicable to determine unit costs with the provision and refinement that obtains in the manufacturing industry. This is due to the variable nature of the construction produce and the frequent change of conditions. Also, since conditions are not identical on any two jobs cost data from one is only an approximate comparison for another. For these reasons cost data must be used as a guide or measure in forecasting future costs. Cost data on new or unusual methods of construction and on the use of various plant units are of particular value as similar conditions are likely to be encountered in the future and a basis for cost estimates is available.

The Principal Cost Elements.—It is believed that the proper basis for a cost system is the four principal elements of cost allocated to the units of production.

(a) Labor Costs.
(b) Material Costs.
(c) Equipment Costs.
(d) Administration Costs or General Expenses.

The products of highway construction to which these cost expenses are assignable to road parts. Fundamentally these parts are:

(a) The right of way.
(b) The roadbed, shoulders and grade.
(c) The traveled way or roadside [illegible].
(d) Drainage channels or ditches and drains.
(e) Drainage structures or bridges and culverts.
(f) Supplementary structures of miscellaneous road parts, such as guard rails, retaining walls, guide posts, etc.

Thus, there are six major products on each of which there must be four elements of expense or cost. Consequently, we have 24 cost divisions. Since general expense is not ordinarily [illegible] directly on production but is pro rated to the various operations, the actual cost divisions with which the cost keeper is directly concerned are reduced to 18. It is believed that this is the minimum number of cost divisions which will provide a satisfactory highway cost keeping system. These cost divisions are susceptible of much further analysis by breaking them up into various operations. For instance, a square yard of concrete roadway is one of the unit products. The cost divisions for this are three, i. e., labor, materials and equipment. To these three may be added the pro rated general expense. For further analysis, the square yard of roadway may be subdivided into subgrade dressing, placing of forms, hauling materials, mixing concrete, placing concrete, curing concrete, etc. This illustrates how the system may be expanded to meet the requirements of any desired analysis.

Distribution of Equipment Costs. In placing the cost items against the appropriate construction items the greatest difficulty appears to be in connection with equipment costs and "administration costs." It is the experience of the Bureau of Public Roads on its own work that these items are given less attention in the preparation of estimates and in the segregation of cost to construction items than the more nearly definite items of "labor" and "materials."

The handling of equipment costs has been greatly simplified by the use of a rental factor computed to cover fixed charges, depreciation, overhauling, lost time, storage, and supervision. In the case of its own plant the Bureau of Public Roads has prepared rental schedules for all units of equipment having a useful life of more than one working season and costing more than $25. Small tools and those which are usually worn out on one job are handled the same as materials. This plan has been in operation three years and except for a change from a monthly to a daily basis it is practically the same as originally developed. It has proven satisfactory on both day labor and contract work of the Bureau. A rental factor of this kind is necessary where current costs are determined for purposes of management. If greater accuracy is desirable for fiscal purposes and annual appraisal of the equipment may be made and the depreciation, repair, storage and other charges pro rated to the projects which have used the equipment.

Suggestions for Handling General Expense Items.—As general expense is not usually assignable directly to units of construction and many of the expenditures do not come to the attention of the cost keeper on the job there is a tendency to overlook this element until the project nears completion, at which time the cost is pro rated to the work completed. The result is a sudden jump in unit costs. Even with this apparent defect this may prove the best method to adopt as it greatly simplifies the handling of general expense items. Where limited funds require careful attention to gross expenditure on a project this method is not recommended. Occasionally it is found that the general expense is quite high in starting a job and if this is pro rated to the small accomplishment during the first few weeks of the work there will be shown abnormally high unit costs which are not a true indication of conditions.

Two suggestions are offered for the handling of general expense. First it will be found advantageous to divide general expense into two parts, one of which includes those items which are chargeable directly to the project and the other the general administrative costs of the organization which must be pro rated to all its various projects. This latter part need not be considered in current cost reports as it does not in any way affect the efficiency of the construction organization on the project. This part of the general expense may be apportioned to the project upon its completion. The second suggestion is that the amount of general expense (project) which is pro rated on current reports be a percentage of the total probable general expense, which percentage to be not greater than the percentage of the project completed. For example, if the project is only 10 per cent complete pro rate to completed work not more than 10 per cent of the total probable general expense. On projects where the cost of "moving in," "camp installation," "organizing," and "disorganizing," is of a considerable amount the unit construction costs are liable to be materially affected if this entire cost is distributed before the work is well under way.

Fundamental Principles for Cost Keeping Systems. A cost keeping system to be successful must be based on certain fundamental principles. First of all it must be designed to furnish the particular information sought. This feature can not be too strongly emphasized as not infrequently much more time is spent in perfecting quasi-scientific forms, codes, and procedure than is given to working out a system for getting at the cost of doing work. The system devised must be reliable and accurate to a practical extent. Insofar as field procedure is concerned simplicity is a very important consideration and it should be such that the required data can be successfully compiled by foreman and timekeepers. The effectiveness of the system will depend to a great extent on the celerity with which the unit costs may be ascertained. Unless the cost of doing the work can be determined easily and promptly its value as an aid to efficient management is lost. Some consideration should be given to making the cost system adaptable to the general work of the organization and not design it entirely for an individual job or set of conditions. It requires time and considerable patience to get a system in working order and frequent changes in forms and instructions should be avoided as they are generally disconcerting to the men in charge of construction work.

It must be understood that cost keeping lies in the general bookkeeping scheme of the organization and is not to be operated independent of the regular accounting. While the cost-keeper and bookkeeper make different use of the information, the basic data used should be the same. One of the reasons cost keeping has not received more encouragement in the past from engineers and contractors has been the question of its cost. A system laid out along the lines indicated and designed to give the information needed for the proper supervision or administration of the work of an organization need not be expensive considering the volume of business it handles. It is when a system is developed beyond the requirements of the organization that cost becomes an important consideration.

A review of the present status of cost keeping on highway work indicates that it is still very much in a formative stage. There are some excellent systems in operation in many of the state highway departments and among the larger contracting organizations, but on the larger part of the extensive highway program cost keeping as practiced leaves much to be desired. A great step forward would be accomplished by a general classification of cost keeping terms. Many of these as not used are subject to several interpretations. Engineers and accountants could materially improve the situation by reaching a common understanding in this regard.

As an indication of the present interest in highway cost keeping it is interesting to note that since the publication by the Bureau of Public Roads of its cost keeping bulletin more than 5,000 copies have been distributed.

Seventeen Years of State Highway Construction in Pennsylvania.—During the last 17 years the State Highway Department of Pennsylvania has put under contract 2,776.95 miles of roadway. During the years 1919, 1920 and 1921, the department completed 1,340 miles of durable highway, and in addition entirely resurfaced 1,207 miles of macadam. The resurfacing operations of the department began in 1914. In the years beginning with 1914 and ending with 1921 the State Highway Department resurfaced 2,409 miles of macadam roadway. The types of roadway comprising the 2,776.95 miles contracted for by the department since 1905 are as follows:

Type	Miles
Macadam	815.95
Bituminous macadam	223.46
Brick	156.11
Bituminous concrete	273.92
Reinforced concrete	1,294.71
Grading and drainage only	11.54
Plain concrete	1.26
Total	2,776.95

Construction Features of Oklahoma Federal Aid Project

One of the most important Federal Aid projects undertaken last year in Oklahoma comprised the paving of 13 miles of the Ozark trail to the east of Oklahoma City. The work was divided into three sections, Allen & Harrison having the largest contract, amounting to 7 miles. These contractors put down an average of 500 ft. of 20 ft. road per 8-hour working day. Their best day's run was 628 ft. Their methods of handling this work afford an excellent example of up-to-date road building.

General View of Allen & Harrison's Paving Job on Norman Road, Federal Project No. 19

The central proportioning plant is located on the Frisco R. R., at a point about 3 miles from the concreting operations. This proportioning plant has individual bins for sand and gravel, which are loaded directly from the cars by a large crane. The crane is mounted on road wheels to which Allen & Harrison have bolted angle flanges so as to operate on rails. Cars are spotted by a cable attached to the crane, and are pulled by it. The bins, which are made in sections so that they can quickly be taken down and moved, have capacities for 100 yd. of sand and 150 yd. of stone. In addition to the bins there is room for storage for 25 cars of material. The sand, crushed rock and cement are delivered in train loads daily to the contractor's switch.

Transferring Crushed Stone from Cars to Loading Plant.

View of Loading Plant; Truck and Trailer Being Loaded at Same Time.

The cement is trucked to the cement house, which has a capacity of 15,000 bbl., and discharged directly into cement hoppers. These hoppers are drawn in near the loading platform and pushed out over the batchboxes when the trucks are in place. When the cement hopper is pushed out over the batchboxes the bottom slide is pulled out of the hopper, and the amount of cement dropped directly out of the cement compartment of the box.

To haul materials to the job four 2½ ton trucks with 42 by 8 pneumatic tires, each coupled to a 2½ ton Army trailer are used. The trucks carry heavy "batch tanks" made of steel, constructed with partitions to hold just the proper proportion of sand, stone and cement for a batch. After being loaded the truck moved over to the new paving to the point where the federal engineer inspects it and the transfer is made by crane and hoisting engine to the industrial railway that carries the load down the road to the work.

Four complete batches are carried on each trip by both the truck and trailer. In addition to the truck method of hauling, industrial cars play an important part in transporting material to this job. Two 5-ton gasoline locomotives, 21 industrial cars, 48 1⅓ batch boxes with cement compart-

[illegible] carrying two batches to the [illegible] in trains [illegible] the mixer on a 24-in. gauge track [illegible] the rails of 35 lb. per yard. The transfer derrick is operated on cable operated by gasoline and transfers the batches from trucks to cars.

The entire placing of concrete for this job is done by a [illegible] paver, equipped with transfer derrick

Cement Proportioning Bins. Truck and Trailer Pass Beneath to Be Loaded.

Transferring Batch Boxes from Trucks to Industrial Cars.

Charging the Paver from Batch Boxes by Derrick.

and distributing boom and bucket. This paver has a capacity of 21 cu. ft. of mixed concrete per batch.

Steel forms are used for finishing. More than 3½ miles of 2-in. pipe is laid from source of water supply to the paver. The water is pumped from a creek through a steam pump and forced through this piping by 150 lb. pressure.

The average amount of concrete laid on this road does not indicate the number of restrictions which hang over this stretch. The Oklahoma State law only permits an 8-hour working day on all state road work, with a mixing time of one minute per batch.

On all large concrete road building jobs the present day machinery eliminates considerable hand labor. On this particular job a comparatively small crew was used. This was duly creditable to mechanical means of transporting material from cars to bins, from bins to the job, and the ability of the paver to handle the materials as fast as they were brought up. In fact, on all concrete jobs it will be found that the handling of material is the heaviest part of the payroll if it is done by hand labor.

Below is listed the equipment and number of men used on this job:

Labor Force.

Unloading cars:	
Crane operator	1
Fireman	1
Men in cars cleaning up	2
Central proportioning plant:	
Sand and stone bin	4
Cement house	3
Truck drivers	4
Transfer derrick:	
Derrick operator	1
Shifting boxes	2
Shifting cars, 1 man and mule.	
Track shifting:	
Foreman	1
Men	5
(Handle all track work.)	
Pump:	
Pump man	1
Locomotive	2
No train crew, except engine drivers at paver.	
Unloading of derrick:	
Derrick hoist	1
Shifting boxes	2
Overhead:	
Timekeeper	1
Bookkeeper	1
Commissary	1
Cook	1
Flunkies	2
Watchmen	1
Working boss	1
Paver:	
Mixer operator	1
Spreaders	2
Finishing machine:	
Operator	1
Operator helper	1
Foreman	1
Water boy	1
Curing and covering concrete:	
Sprinkling	1
Foreman	1
Men	4
Cover Concrete and Take Up Forms.	
Form setting:	
Foreman	1
Men	3
Fine grading:	
Grader	1
Helpers	2
Also team and man	1
Repairs:	
Blacksmith	1
Master-mechanic	1
Helpers	2

Consolidation of Broken Stone by Two Rollers of Different Weight

The French Minister of Public Roads has caused a certain number of experiments to be carried out regarding the use—in the construction of metalled roads—of two or more rollers of different weight operating in succession on the resurfacing material. The lighter roller passes first over the road smoothing out the stone and compressing it slightly; the heavy roller follows, and completes the consolidation. The experiments were carried out in the Department de la Meuse, in the Verdun district.

A recent bulletin of the Permanent International Association of Road Congresses contains the following quotations from a report setting forth the advantages which have been derived from the new method, as compared with the method of rolling by means of one heavy roller only.

> Trials were commenced with two rollers, one weighing 12 tons and the other 16 tons, at the beginning of April, 1921. The results obtained appeared to us to be satisfactory, and we are continuing to employ two rollers for resurfacing work.
>
> In the first place, this method of procedure allows of the better grouping of plant, moreover, supervision and control are better exercised, and the output of the personnel is increased.
>
> The daily quantity of stone rolled is greater than that attained by two roller-crews working separately.
>
> By operating first on one half, of the width of the carriageway and then on the other half, a perfect longitudinal joint is secured, which is difficult to attain with a single roller.
>
> Water is used to better advantage; the passage of the first cylinder brings to light any holes which can easily be repaired before the passage of the large cylinder finally compresses the surface.
>
> There is, moreover, a slight economy in personnel which would be even greater if the four men working the two hand-pumps were replaced by a small motor-pump thus allowing three men to be dispensed with.
>
> To sum up, this method gives good results and we are of opinion that the use of two rollers in the execution of resurfacing work is to be recommended.
>
> The experiments carried out, although only extending over a relatively short period, appear, briefly, to give good results, particularly in those portions of the roads rolled in two operations as is almost always the case in the Verdun district. In view of this conclusion it has been decided to proceed with similar experiments in two other sub-divisions of the Department.

Standardized Specifications for Mineral Aggregates for Asphalt Pavements

Physical Properties Essential to Success of Various Aggregates in Different Types of Construction Set Forth in Paper Presented Jan. 17, at the Good Roads Congress

By ROY M. GREEN,
[illegible] Western Laboratories, [illegible]

Many of the other details involved in arriving at satisfactory standard specifications for the construction of the various types of asphalt pavements are much simpler of solution than that of drawing up a suitable standard for the requirements of the mineral aggregates which must be universally adopted. For example, the asphalt cements that have been successfully used for the various types of work have been classified and placed in suitable groups for description in specifications and their physical properties are carefully controlled by the producers. Since the physical and chemical properties of the asphalt cements that have been used successfully are known, and there are relatively few producers of such materials, it is much easier to arrive at a suitable specification for them than is the case with the mineral aggregates where there are just as many different classes of materials as there are deposits of rock and gravel and their properties can not be controlled further than to regulate the maximum size of the particles and the variation in sizes. Realizing these facts, it is readily appreciated that the materials available for use for any type of pavement in the different sections of the country will vary through a wide range. Since it is always desirable to obtain the best material in each locality, if it can be done economically, it is impossible to draft a standard which will be suitable for all parts of the United States. For these reasons, I believe that the standardization of the specifications for the aggregate to be used in the various asphalt pavement mixtures should not be arbitrarily drawn, especially since there is a tendency of many engineers to adopt standard specifications blindly without regard to local conditions of supply or local experience with materials that have been used successfully. A standard specification for aggregate is of no value except as a guide in drafting specifications for local conditions and as a means of pointing out to the average engineer those points which should be taken into consideration in the description of materials desired for a specific purpose. The adoption of a standard specifications, in its entirety, often shuts out some local material of considerable merit, and in some cases may entirely shut out a type of construction by placing unnecessarily rigid requirements on certain materials that are essential for that type. In other words, standards for the requirements of the physical properties of aggregates should be based upon the materials available in any locality and should be drawn so as to admit all aggregates that have proven successful in like construction in the past, and should be strict enough so that all materials that have proven inferior are excluded.

In the discussion of this subject it is, therefore, my intention to discuss the physical properties that are essential to the success of the various aggregates for use in the different types of construction. The definite limiting test requirements given in the following pages are not intended for universal application but are what I consider as good practice for the materials available for use in Nebraska and adjoining states.

Since the properties of the mineral aggregate which are essential to the success of a bituminous wearing surface mixture are dependent upon the type of mixture which is contemplated, it will first be necessary to designate the types which are to be discussed.

For the purposes of this paper, the asphalt paving mixtures will be divided into four classes, as follows:

1. Sheet asphalt wearing surface mixtures.
2. Asphaltic concrete, with the material passing the 10 mesh sieve predominating.
3. Asphaltic concrete, with substantial proportions both passing and retained on the 10 mesh sieve.
4. Asphaltic concrete, with a preponderance of material retained on the 10 mesh sieve.

Sheet Asphalt Wearing Surface Mixtures. The function of the aggregate in a sheet asphalt wearing surface mixture is simply to furnish a medium whereby a high percentage of bitumen may be carried and still produce a mixture with density sufficient to prevent the entrance of water, toughness and elasticity sufficient to prevent cracking and spalling of the surface, and rigidity sufficient to prevent rolling and waving.

Through a long experience with this type of mixture it has been learned that this sort of a combination can best be produced by means of a mixture of properly graded sand, with the addition of a suitable amount of Portland cement or stone dust. Any properly graded sand that is made up of particles of sufficient toughness will meet the requirements for sand for this type of construction provided it is clean and does not contain too much material passing the 200 mesh sieve. The Portland cement or limestone dust is simply added to fill the smallest voids in the aggregate combination, thus promoting stability, and to increase the toughness of the mixture through the fact that the asphalt cement is absorbed by this aggregate to a very large extent. Experience has also shown that very fine sand, in large amounts will not replace the Portland cement or limestone dust as a filler but is in fact undesirable. This point should be covered by the specifications.

Since the finished product desired for this type of construction is known, it is not necessary to specify the grading of the sand desired and subsequently repeat this in the specifications for the finished mixture, as is so often the custom.

This being the case it is only necessary to specify that the sand shall be clean, hard, and durable, the grading being given in the formula for the finished mixture. The amount of material passing the 200 mesh sieve should be limited. The description of the sand could be, as follows in the specifications.

"Sand for Wearing Surface Mixture." The sand for the wearing surface mixture shall consist of clean, hard, durable grains, free from clay, loam and other foreign matter. Not more than six (6) per cent of the sand for the wearing surface mixture shall pass a 200 mesh sieve and it shall be so graded as to produce a wearing surface mixture as hereinafter specified under "Composition of Wearing Surface Mixture" when combined with the mineral filler and asphalt cement.

Since the mineral filler in the mixture adds to its toughness by assisting in retaining a larger proportion of bitumen, by absorption, it is essential that it be fine enough to act as a true filler. The description of the filler could be given in the specifications as follows:

"Mineral Filler." The mineral filler shall consist of limestone dust or Portland cement, which when tested by means of laboratory screens shall meet the following requirements:

	Per Cent.
Passing 40 mesh sieve	100
Passing 200 mesh sieve, not less than	75

If this type of specification is used for the mineral aggregate it then becomes necessary to give a complete formula for the desired finished product. The following is suggested as being suitable for this purpose:

"Composition of Sheet Asphalt Wearing Surface Mixture." The materials entering into the wearing surface mixture shall be combined in such proportions as to produce a mixture conforming to the following limits of composition, by weight:

	Per Cent.
Bitumen	9.5 to 12
Aggregate.	
Passing 200 mesh sieve	10 to 16
Passing 100 mesh and retained on 200 mesh sieve	5 to 20
Passing 80 mesh and retained on 100 mesh sieve	5 to 20
Passing 40 mesh and retained on 80 mesh sieve	20 to 40
Passing 10 mesh and retained on 40 mesh sieve	15 to 45

The finished mixture shall have not less than thirty (30) per cent of aggregate passing the eighty mesh sieve.

Although these specifications have been reduced to a very simple statement of requirements it must be understood that the aggregate grading must be carefully controlled, within the limits given, by some one who is competent to supervise this type of construction.

Asphaltic Concrete, With the Material Passing the 10 Mesh Sieve Predominating.—In this type of construction, which includes the Topeka mixture, a small amount of stone is introduced in the mixture of fine bituminous mortar. The purpose of this stone in the aggregate is simply to reduce the cost of construction by reducing the surface area to be coated by the asphalt cement, since it requires much less bitumen to thoroughly coat the stone which is replacing a like volume of fine aggregate. The stone, or large aggregate, in this type of mixture does not contribute to its stability in any way as each particle is completely surrounded with the fine bituminous mortar and the larger particles are never in contact with each other. The success of such a combination is then dependent upon the correct proportioning of the finer particles of aggregate the same as in the case of the sheet asphaltic wearing surface mixture. For this reason it is just as essential to produce a properly graded material having the same physical properties as the material used for the fine aggregate in the sheet asphalt. The specifications for the sand to be used in this type of construction should, therefore, be the same as for sheet asphalt.

The large aggregate is exposed in the surface of the pavement over a relatively small area of the total and it is therefore not so essential that the particles be as tough and hard as for use in mixtures where a very large area is exposed in this way. It is also absolutely essential that the maximum size of these particles should not exceed ½ in. in diameter as they are entirely surrounded by a bituminous mortar and if the size is great there will be a much greater tendency for movement in the mixture, due to stresses at their edges.

In drawing specifications for the aggregate entering into pavements of this class it is well to specify limits of toughness and resistance to abrasion as well as requirements for cleanliness and a limit to the maximum size. The properties of the local materials that have been successfully used should be kept in mind in order that those materials that have given satisfactory service may not be eliminated by requirements that may be too strict. If this type of mixture is contemplated the following specifications for the coarse aggregate are suggested.

"Stone." The crushed stone shall be produced from rock having a French coefficient of wear of not less than eight (8) and a toughness of not less than eight (8) when tested in accordance with the methods described in the U. S. Department of Agriculture Bulletin 347, pages 4 and 11 respectively. The crushed stone shall be reasonably uniform in quality and free from soft or disintegrated particles and shall vary from one-half (½) an inch to the smallest particle retained on the finest mesh screen commonly used in stone crushing plants.

The specifications for sand and mineral filler should be the same as for sheet asphalt wearing surface mixtures as they serve a like purpose in this type of construction and should therefore be identical.

When this type of specification is used to describe the aggregates it is then essential to give a complete description of the formula for the completed mixture. A good specification and one which is in very common use is as follows:

	Per Cent
Bitumen	7 to 11
Aggregate:	
Passing 200 mesh sieve	5 to 11
Passing 80 mesh and retained on 200 mesh sieve	10 to 25
Passing 40 mesh and retained on 80 mesh sieve	11 to 36
Passing 10 mesh and retained on 40 mesh sieve	7 to 25
Passing ¼ inch screen and retained on 10 mesh sieve	11 to 25
Passing ½ inch and retained on ¼ inch screen	5 to 10

Asphaltic Concrete, With Substantial Proportions Both Passing and Retained On the 10 Mesh Sieve.—When Mixture Is Used as a Wearing Surface: When properly designed this class of mixture produces a dense asphaltic concrete with a high percentage of well graded stone, the particles of which are in very intimate contact with each other. The function of the stone in this mixture is to add to the stability of the combination by interlocking, and to reduce the surface area to be coated with asphalt cement and thus reduce the cost of construction. In order to be satisfactory in this aggregate the stone must have sufficient toughness and hardness to resist the internal wear that may be set up in the mixture as well as withstand the shocks of traffic that come directly upon the surface of the pavement. For these reasons it is essential that the stone be harder and tougher than that used in the preceding class of asphaltic concrete.

The mortar surrounding the particles of large aggregate in this combination must be suitably designed and proportioned also, in order that it may protect the large aggregate by holding it securely in place and thus prevent internal wear. The mortar must also cushion the effects of traffic on the surface so that the shocks will not be great enough to completely crush the large aggregate. To accomplish this purpose the sand must be properly graded the same as in the two preceding classes of pavements. The following clause will cover these details.

"Coarse Aggregate." The mineral aggregate shall consist of hard crushed stone or an approved mixture of hard crushed stone and gravel for the coarse aggregate. Not less than ninety (90) per cent of the coarse aggregate shall pass a one (1) inch screen. To the coarse aggregate shall be combined sand or a mixture of sand and fine stone screenings for the smaller sizes. The large aggregate, or that portion of the mineral aggregate larger than one-quarter (¼) of an inch in diameter shall be composed of stone or gravel, all of which has been produced from materials having a French coefficient of wear of not less than ten (10) when tested in accordance with the methods described in the U. S. Department of Agriculture Bulletin 347, page 4. All the crushed stone larger than one quarter (¼) of an inch in diameter shall be produced from materials having a toughness of not less than ten (10) when tested in accordance with the methods described on page 11 of the U. S. Department of Agriculture Bulletin 347.

The coarse aggregate shall be reasonably uniform in quality and free from soft or disintegrated particles, or other objectionable matter occuring free or as a coating on the aggregate, and free from an excess of flat or elongated pieces.

When this type of specification is used it is necessary to also give the formula for the mixture desired. The following is suggested for this purpose:

"Composition of Dense Bituminous Concrete Wearing Surface Mixture." The dense bituminous concrete wearing surface mixture, produced in the manner hereinbefore set forth, shall contain the following percentages, by weight of bitumen and aggregate, the sieves being used in the order named:

	Per Cent.
Bitumen	5 to 8
Aggregate:	
Passing 200 mesh sieve	4 to 10
Passing 80 mesh and retained on 200 mesh sieve	4 to 14
Passing 10 mesh and retained on 80 mesh sieve	18 to 30
Passing ½ inch screen and retained on 10 mesh sieve	24 to 35
Passing 1 inch and retained on ½ inch screen	20 to 38
Passing 1¼ inch and retained on 1 inch screen	0 to 10

The finished mixture shall have from fifty-five (55) to seventy (70) per cent of mineral aggregate retained on a 10 mesh sieve, and not less than ten (10) per cent passing an 80 mesh sieve.

When Mixture Is Used as Closed Binder in Sheet Asphalt Construction.—When mixtures of this class are used as closed binder in sheet asphalt construction and combination is made up of a mixture of fine and coarse aggregate with asphalt cement, without the use of the fine filler of Portland cement or stone dust. The functions of the coarse and fine aggregates are the same as in the case where it is used as a wearing surface. The large aggregate, however, need not be nearly so tough and hard since the shocks of traffic never come directly upon it and there is no possibility that there will be internal wear as the combination is always protected by a layer of fine bituminous mortar to a depth as great as one or even two inches.

The requirement for the sand should be the same as for other types of construction although the stone may be much softer. A suitable specification describing the stone might be as follows:

"Stone for Binder Course." The stone for the binder course shall be produced from tough and durable rock having a French coefficient of wear of not less than six (6) when tested in accordance with the methods described in the U. S. Department of Agriculture Bulletin 347, page 4. It shall be reasonably uniform in quality and free from foreign substances. When tested by means of laboratory screens it shall meet the following requirements and be uniformly graded between the limits given:

Passing 1-in. screen, not less than	95 per cent
Passing ¼ in. screen, not more than	10 per cent

Asphaltic Concrete, with a Preponderance of Material Retained on the 10-Mesh Sieve. When used as a wearing surface: This type of mixture is made up of a commercial size of broken stone or of "one size stone" mixed with a bituminous cement. The mixture produced in this way is not an absolutely dense solid and no attempt should be made to fill the voids with the asphalt cement. The stability of the mixture is almost entirely dependent upon the interlocking of the large aggregate and the wearing qualities of the surface are almost entirely dependent upon the hardness and toughness of this material. For this reason it is absolutely essential that this material be as tough as possible in order to withstand the shocks of traffic and resist the effects of internal wear which is inevitable when this type of mixture is used.

The limits of the properties of the mineral aggregate that should be specified are dependent upon the amount of traffic that must be carried by the surface. If it is absolutely known that the traffic is to be composed entirely of rubber-tired vehicles and is very light it is safe to allow the use of much softer rock than if the amount and nature of the traffic is unknown or is known to be severe and to consist of a large proportion of iron-tired vehicles. If a severe traffic is contemplated it is necessary that the aggregate should be better than for any other type of asphaltic concrete mixture inasmuch as the aggregate must be of such quality that it is capable of carrying all the wear of traffic including internal wear and abrasion of the surface.

A reasonable specification for this type of material is that recommended by the American Society for Municipal Improvements in 1917, which is as follows:

"Tests": The broken stone shall be subjected to abrasion and toughness tests conducted by the engineer in accordance with methods adopted by the American Society for Testing Materials, Aug. 15, 1908. The broken stone used for the construction of the wearing course shall show a loss on abrasion of not more than 3.5 per cent or a French co-efficient of wear of not less than 11.5 and its toughness shall not be less than 13.0.

Mixture Used as Open Binder in Sheet Asphalt Construction.—If this class of mixture is used as an open binder for sheet asphalt construction the requirements of the aggregate are the same as for the aggregate for closed binder, already described.

In closing I wish to again draw your attention to the fact that it is not good policy to recommend, for universal adoption, a specification for the mineral aggregate for asphalt pavements and place limiting tests requirements on these materials because of the fact that materials differ so widely in nature in different localities and it is always advisable to draw specifications for materials so as to allow the use of only the best materials available in any locality so long as competition is obtained and the interests of economy served. While the specifications quoted are not intended for universal adoption it should be noticed that the large aggregate should be of better quality for the cheaper types of construction than for the more expensive. The last form of asphaltic concrete requiring the best large aggregate while sheet asphalt binder and also "Topeka" may be constructed by the use of poorer grade of stone.

For successful results with any specifications it is also absolutely essential that the mineral aggregate grading be controlled within very narrow limits by one who understands the fundamental principles underlying the various asphalt paving mixtures and who is experienced in their construction.

Steam Shovel Moved 15 Miles Up to 15 Per Cent Grades Under Own Power.—In constructing the Berthoud Pass road in Colorado, a steam shovel was moved 15 miles under its own power up 15 per cent grades to start work at the highest point. The government forest road crosses the Front Range at an elevation of 11,300 ft.

Asphalt Used for Curing Concrete Pavements

By B. H. PIEPMEIER,

Engineer of Construction, Division of Highways, Illinois State Department of Public Works and Buildings

During 1921 Illinois experimented with the use of asphalt in curing concrete pavements. The experiment was tried on about two miles of road built by day labor near Frankfort, Ill., and was in connection with a central mixing plant where no water line was needed along the road.

As it was desired to remove the asphalt coating used for curing purposes, it was decided to use a blown asphalt and apply it on a damp surface that was slightly dusty to prevent the asphalt from sticking. The asphalt was first applied soon after the final set and while the surface was still moist. This method did not work out entirely satisfactorily, chiefly on account of transporting the heating kettle over the green concrete. A properly designed heating kettle would permit it to be pulled over the green concrete, ahead of the coating. However, with the equipment that the state had available it was more economical to broom the surface with a light coating cement after it had become sufficiently hard to support a 100 gal. steel wheeled kettle without injury.

Various Stages of Process of Curing Concrete Pavements by Coating With Asphalt.

The asphalt was applied at the rate of approximately 6/10 gal. per square yard and after the three weeks' curing period had elapsed it was peeled off, rolled up, carried ahead and re-heated. A large amount of the asphalt was re-used on the second application and a small amount of it the third time. On account of the dust and dirt collected by the asphalt the second and third heating was very difficult and unsatisfactory.

The results obtained from the use of the asphalt were apparently satisfactory. This method was tried out during the hottest weather of the summer and at all times there seemed to be moisture beneath the asphalt blanket when it was peeled off. Laboratory experiments have indicated that pavements can be cured with this process about as satisfactorily as with the use of earth and water, which is the most common method followed.

The cost of the work done at Frankfort was approximately 6½ ct. per square yard.

Road School for Kansas County Engineers.—The Kansas State Agricultural College, Manhattan, Kan., will hold its annual county engineers' road school on Feb. 14-24. Six major courses will be offered: three in the morning from 8 to 11 and three in the afternoon from 1 to 4. It is expected that each engineer registering will choose one forenoon and one afternoon course. In addition to the major courses there will be two lectures or seminar periods a day: one at 11 a. m. and one at 4 p. m. It also is hoped to have a large number of outside speakers present topics.

Michigan Conference on Highway Engineering.—The 8th Annual Michigan Conference on highway engineering will be held at the University of Michigan from Feb. 13 to 17. An excellent program of papers by leading highway engineers has been prepared. One day of the conference will be devoted as road commissioners' meeting, at which reports will be made by representatives of county highway departments. On the evening of Feb. 16 there will be an informal dinner of the Michigan Road Commissioners' and Engineers' Association.

An English Engineer's Impressions of the Road Show

[It was the good fortune of Engineering and Contracting to have as its guest at the time of the good roads exhibition in Chicago a British member of the profession who took much interest in the various exhibits and has given us the following account of his observations at both show and conference.—Editor, Engineering and Contracting.]

Although I have made several visits of considerable length in the States, this road congress and show has furnished my first opportunity of seeing one of your great industrial exhibitions. It is difficult to decide whether I was the more impressed by the scope and magnitude of the display or by the character of the individual exhibits. Frankly I was surprised at both.

One other feature also attracted my attention unexpectedly. I refer to the conspicuously happy spirit which one encountered everywhere as he went about the exhibition. The fame of Americans as money makers is quite understandable if they always make as pleasant a job of it as they did at this show where, I suppose, the Government was the only exhibitor whose primary motive was not commercial. Wherever one went he met a cheery smile and a readiness to explain, even although he announced himself as no possible purchaser.

Of the exhibits, the construction equipment impressed me most and I confess to a pleasurable sense of childish wonder at the sight of so many great machines, all fresh and trimly painted, and exhibited together under a single roof. Just by way of contrast there was here and there a service-marked unit accompanied by a placard reciting its age and the history of its use.

American ingenuity is justly famed and quite freely admitted in England, but there is a feeling among many of my countrymen that American machine construction is generally flimsy. Corroboration of the first of these ideas and confutation of the second were contained in the road exhibitions at Chicago. True, there were exceptions, but they were notably few. I would not say that the construction generally was as solid as is British construction, but it could not in fairness be called flimsy; and it is quite possible that it is more truly economic than are the British types. There has been a growing feeling among us from across the Atlantic that many of our machines are made unreasonably heavy and durable—especially machines subject to supersession by frequent improvements in the arts.

Perhaps the mechanical tampers for concrete roads and road bases afforded the strongest evidence of the rapid developments now being made in the art of road building. I do not know just how long it is since the first of these was placed upon the market, but I have been in sufficiently close touch with road building affairs to be sure that it is only a very few years. Yet here were seven or more tamping machines, each with its demonstrator eager to show you its superiorities. The machines were of two types—power and hand operated—the latter being designed for comparatively narrow roads. I wish that I might see each of them in actual operation.

I was very greatly interested in the subgraders, of which both rotary and rectilinear types were on display. These machines are for trimming rough grading to an exact surface preparatory to the placement of paving materials. Like the tampers they do a work which until recently was limited to hand labor with small tools.

It appears that the limit of development in concrete mixers is about reached, yet I dare not venture an actual prediction to that effect. Here at the show there are many sizes and types, but the most interesting features to me are in these accessories. The great paving units are certainly monuments to the skill of the designers and the progress of road building. Nevertheless one may reasonably hope for further great improvements in the means and methods of distributing the mixture upon the prepared ground surface.

The automatic measuring devices for concrete materials offer a very great improvement over older methods especially in the elimination of doubtful human elements, and [illegible] of accuracy in the proportions. In this connection one also thinks of the development of batch boxes for handling and charging the mixed materials. One unit was provided with a special crane which handled these boxes most expeditiously and conveniently. In this connection I should mention that this exhibition is rendered vastly more interesting by the operation of much of the equipment on display. Of course the actual burning of any kind of fuel in engines exhibited in a closed building is impracticable, but by the attachment of electric motors, almost every important machine was shown in motion. Even some of the heavier tractors were jacked with their driving wheels off the floor and turning at slow speeds to show fully the operation of their parts. The mixers and the tampers made much noise, but it was of an appropriate and pleasant sort on such an occasion.

I understand that central mixing of concrete for road purposes is growing rapidly in favor, and I noted with much interest the special equipment for handling it, auto trucks with special bodies for use where suitable roads are available, and industrial tracks and cars for other conditions. The use of batch boxes with the latter equipment appeals to one as a most practical and desirable development. There were both large and small working models of central plants, from which one could form a very excellent idea of the operations of the actual outfits.

One manufacturer of drag-line equipment had a small, although very complete model including a stage and trap, all mounted in a box with an adequate supply of sand which he perpetually excavated in highly graphic fashion. There were beautiful models of excavating buckets and other equipment including road graders and tractors. But on the whole the number of models was somewhat of a disappointment. Good models tell a great deal in little space, and it is my belief that Americans would find it to their advantage to use them more than they do.

In grading machinery, I will confess that aside from the "subgraders" which I have mentioned, I found little of which I did not already know. Very few plows were on display, although what I saw appeared as of excellent quality. Among the blade graders there were some developments in light weight machines for surface trimming, some minor blade adjustments and one or two attachments, but nothing radically new. There were also but few rollers on exhibition—perhaps because of the lessening use of macadam and gravel surfaces.

Of the tractors, trucks and truck bodies I shall not attempt to speak in any detail. It was, however, most interesting to see so many makes and types together, and the prospective buyer who attended the show had an excellent opportunity to compare their merits. The turn tables for trucks were of special interest, and I regret that I am not likely to have an opportunity of seeing them in operation on actual construction. Elevating loaders, oiling and sprinkling equipment, asphalt outfits, engines, pumps, and many other machines deserve comment which I am unable to give.

The displays of road materials and pavement samples were neither numerous nor large, but the exhibitors had provided very complete and interesting literature, and their representatives were ready with a large fund of information and courteous explanation.

Conspicuous on the balcony of the exhibition building were the flashing lights of an automatic gas signal company; and on the opposite side were exhibited pavement lights of the mushroom type. Among what might be termed miscellaneous exhibits there were bridge models, several attractive displays of engineering instruments, culvert pipes, reinforcing materials, forms, and hand tools; but it is quite impossible to mention them all.

The engineering papers and other interested periodicals were well represented, and their booths were always busy when I observed them.

The extent to which the moving picture has become an everyday affair was one of the conspicuous incidents of the exhibition. Scattered about the hall, in how many places I do not know, were small, self-contained outfits, in which pictures of working equipment were projected on hooded screens so brilliantly that the passer-by might stop for a glance at them without the least interference from the main lighting of the building. Almost every one of these "movies" had a small group of people continuously in front of it.

The exhibit of the justly famed U. S. Bureau of Public Roads was a disappointment. Probably the work of the

Bureau is so well known to all who are actively engaged in road building that little can be gained by advertising among them, but there were doubtless many others among the visitors at the exhibition who would have liked to learn more of its work. There were a few models of road structures, a moderate display of apparatus for both physical and chemical tests of materials, and some of the smaller instruments used in testing pavements in service. A considerable display of pictures of roads and scenery throughout the States was to me the most interesting features of this exhibit, but even these were by no means what they might have been, their coloring and general character being generally inferior.

It will be noted that I have attempted little by way of comparison between things American and things British, for neither time nor space permits me to go far in that matter. Undoubtedly American equipment on the whole is well designed and built to fill American needs. Nevertheless Americans could no doubt profit from a study of British types, and I have no hesitancy in admitting that we should learn much from America. Differences in weight of construction equipment I have already noted, but of more fundamental importance are the differences in weights of road using equipment. Our trucks, tractors and other vehicles not only average much heavier than do the American types, but the heaviest, or limiting types, are conspicuously heavier. This of course necessitates heavier pavements, and I should say that the greatest problem before American road engineers today is to decide on whether they should continue to build roads of a strength approximately the same as that now most in favor, or whether they should begin to provide for substantially greater vehicle weights. If the former course is adopted, it will require the careful and rigid limitation of weight: if the latter, it will be necessary either to restrict vehicle weights on much of the existing pavement or else to rebuild at an early date many millions of dollars worth of recently completed work. It is truly a problem of the first magnitude, and one requiring the deepest study. The only comment which I feel warranted in making upon it is that with the tremendous mileage of road necessary to serve the United States, and the desirability of keeping as many miles as possible open to all classes of traffic without restriction, it may be economic to use lighter and cheaper construction than is used in England, and to limit all vehicles so that it may not be too quickly destroyed.

The cosmopolitan character of the attendance at the exhibition was conspicuous to a Britisher; and, I take it, was fairly representative of large numbers of the better class of Americans. There were many surveyors and engineers, contractors in a large way and in a small way, commissioners, road supervisors, mechanics, machine operators, machinery and materials salesmen, and a sprinkling of students, as well of course, as many whose status was not at once apparent. But they were all of an earnest and energetic type—the sort of industrious folk, I thought, who have been chiefly responsible for making the United States what they are. They wanted to know the whys and wherefors, and it was interesting to note the minuteness with which presumable prospective buyers examined the machines. Some of them could even be seen going under the machines regardless of consequences to their clothes in order to observe every part of the mechanism.

I attended only two of the meetings of the convention. Both of them I found interesting, but neither as large nor as enthusiastic as I had expected. In England we have the idea that Americans are always eager for the opportunity to talk and to argue, but such tendencies were little in evidence at the convention. Personally, I found the speeches very interesting, and could but wonder at the mild interest and perfunctory applause.

In conclusion let me say that I leave Chicago with a feeling of time well spent, another pleasant recollection of American hospitality, and a distinctly increased respect for American engineers and constructors. Should I be so fortunate as to have an opportunity to visit another of these great road exhibitions and conferences, I shall certainly avail myself of it.

Culvert Pipe Delivered by Parcel Post.—In constructing the Klamath River forest road in California the contractor found the cheapest method of delivering culvert pipe a distance of 100 miles from the railroad to be by parcel post.

3-Inch Brick, Laid Flat, and Asphalt Filler Features of Meadville, Pa., Paving

By ROY L. PHILLIPS,

City Engineer, Meadville, Pa.

The city of Meadville, Pa., with a population of about 15,000, has just completed the construction of 62,000 sq. yd. of vitrified brick pavement.

Twenty-five years ago Meadville constructed its first hard surfaced street, using vitrified brick. Since then a total of 21 miles of city streets have been paved with this same surfacing material. The only other pavement in the city is a stretch of 0.6 miles of asphalt block. Of the total of 21 miles of brick, all except about 600 ft. is giving satisfactory service today.

Despite this record of excellent service, we believed we could do even better. This summer, therefore, we took the step which, in our opinion, will lead us to the desired result. We supplanted cement grout with asphalt filler, and laid the brick flat, to the depth of 3 in.

Laying 3-in. Vertical Fibre Brick on Lord St., Meadville Pa.

The type of construction of the 62,000 sq. yd. was as follows:

Five inch concrete base of 1:3:6 mix. 3 in. by 4 in. by 8½ in. square edge brick laid flat on a sand cushion, and asphalt filler. The squeegee method was used and the asphalt was applied at a temperature of 350° to 390° F. Specifications of the National Paving Brick Manufacturers Association were followed.

The cost of the asphalt applied, exclusive of the contractor's profit, ranged from a minimum of 14 ct. a square yard to a maximum of 20 ct. a square yard. The contract price of the pavement from curb to curb, exclusive of the cost of the curb but including the grading and other expense, was $3.85 a square yard.

After the asphalt filler had been squeegeed so as to completely fill the joints between the brick, the pavement was sprinkled with sand and rolled with a 5-ton roller. For the benefit of those who might fear the results of rolling 3-in. brick with such a heavy roller, I might state that no more of the brick were cracked than is customary where the brick are laid to a depth of 4 in.

One of the 3-in. brick streets completed early in the season has been subjected to the most severe traffic all summer. Hundreds of heavily loaded motor trucks, carrying stone and other road material, outward bound, for the improvement of a country road, used this new pavement. It shows not the slightest sign of injury or wear, and lives up to our utmost expectations.

Federal Forest Road Progress.—During the fiscal year ending June 30, 1921, the advance in forest road construction has been greater than in any previous year, according to the recently issued report of Thos. H. MacDonald, chief U. S. Bureau of Public Roads. In all 67 projects were completed or brought to approximate completion during the year, totaling 719 miles. In addition 59 projects totaling 690 miles were under construction on June 30. The total cost of the completed projects was $5,371,000, of which $3,449,000 was Federal funds.

New Light Dumping Body

A universal dump body for the Ford one-ton truck has recently been brought out by The Eagle Wagon Works of Auburn, N. Y. The most striking features of the new body are the steepness of the maximum dumping angle, speed and convenience of operation and the complete control of the dumping operation.

The body is substantially built of 1⅛-in. birch. Its inside dimensions are: Length, 86 in., width 43¾ in., front depth 13½ in., rear depth 17½ in. The capacity is 1¼ cu. yd. water level or 1½ cu. yd. rounded measure. Flare boards and steel lined bottom come as regular equipment. Complete steel lining and coal chute door in the tail gate are supplied as specials when desired. The weight complete, including subconstruction and dumping device, is about 700 lb.

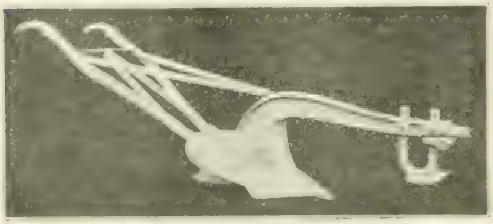
Eagle Universal Dump Body.

The maximum dumping slope is 64°. With the truck standing level and the body clearing the ground by 16 in., the slope is 35°. Operation is entirely from the seat, the mechanism consisting of a simple chain, lever, and ratchet device, with the addition of a foot brake whereby the load can be slowed up or stopped entirely at any point. Also it can be locked at any point of the dump. Three seconds is generally sufficient for dumping where the dump is to be made all at once.

The tail gate opens and closes automatically, and is removable without the disturbance of any bolts or nuts or the pulling of any pins. The floor board containing the dumping device is of standard size adaptable to any of the well known cabs on the market. The wind-up process can be carried out in from 20 to 30 seconds while the driver is making the return trip after dumping, thus adding nothing whatever to the time consumed in the operation.

Convertible Plow for Heavy Work

The name "Contractors' Plow No. 69" is the name given by the Ward Plow Co. to a heavy all-steel plow which will, as desired, turn a large furrow or serve as a rooter of macadam pavement or other hard material. For the latter use the steel wing shown in the picture below the mold board is removed.



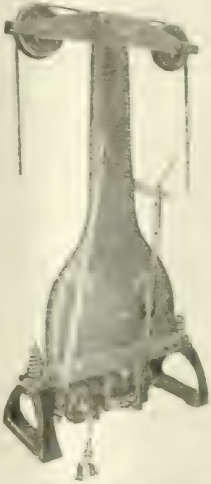
All Steel Convertible Plow

The No. 69 plow is stated to have proved highly satisfactory for both ripping and rooter work. Its heavy design makes it especially suitable for use with lower traction on work too heavy for satisfactory handling by teams; although it is adapted to use with teams where the work is lighter.

The weight with clevis is 315 lb. The beam is made of one piece of cast steel. The point is of forged steel, 33 in. long, 1¼ in. wide, and reversible to give double wear. It is attached with three bolts, countersunk to present a smooth surface. Bosses on the steel beam fit the countersinking on the inner side of the point, thus holding it securely in place and preventing the shearing off of bolts. Both wing and moldboard are made of forged steel, the latter extra thick on the parts subject to most wear. Extras of all parts are available.

New Power Hoist for Trucks

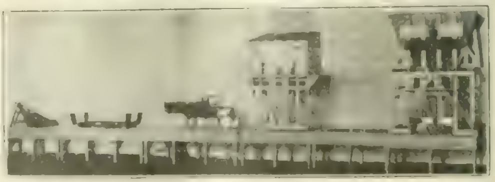
A direct and positive action power hoist has been placed in production by the Columbian Steel Tank Co., 1405 W. 12th St., Kansas City, Mo. In this hoist the power of the truck's motor is transmitted direct from transmission take-off or propeller shaft to lifting cables through clutch-controlled bronze worm and bull gear—the cables winding concentrically over bull gear drum effecting ever increasing elevation speed and ever decreasing descent speed. A two way, combination disc and cone-clutch operating on the worm shaft controls elevation and descent and in neutral holds the body at any stage of the elevation. This hoist weighs 400 lb. complete with cables, lift arms and take off and mounts in a 15-in. space. It is claimed to dump in 30 seconds or less, depending on the speed of the truck motor. Its lifting capacity is 10 tons, and the dumping angle is 45° or more, according to the hinging point of the dump body.



Columbian Motor Motive Hoist

Miniature Layout of Road Building Equipment at Good Roads Show

An interesting exhibit at the Chicago Good Roads Show was that of the Kissel Motor Car Co. This consisted of special quarter size models of equipment used in road building. The miniature layout is shown in the illustration. On the left is the skip end of the mixer, then comes the specially



Good Roads Show Exhibit of Kissel Motor Car Co.

designed turntable. Next is a replica of one of the special Kissel road builders trucks, which was designed and built to carry a 3 cu. yd. body divided for 3 batches of 1 cu. yard each. Next comes the Kissel designed and built and patent applied for combination cement hopper and measuring boxes under which the Kissel truck is driven and receives its properly measured load of cement. At the right is a Kissel designed, patented and built combination sand and stone hopper and measuring boxes which dumps properly, proportioned loads of sand and stone into the 3 batch body.

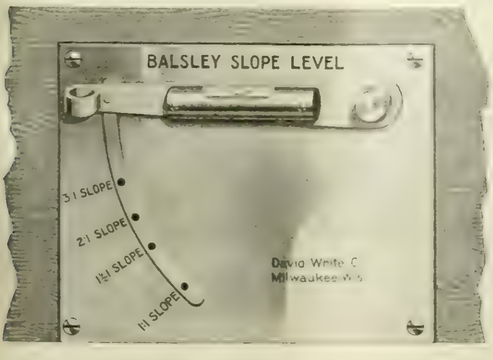
New Self Dumping Body

A new self-dumping body having rockers on the outside instead of the bottom has been placed on the market by the Eastern Car & Construction Co., 50 Church St., New York City. The body is designed for handling all kinds of loose or flowing materials and is furnished for use on any make of truck, including the Ford. It is stated that it can be attached in 10 minutes by means of four simple U-bolts, no drilling or fitting of any kind being necessary. The body proper is made throughout of No. 10 gage blue annealed steel plate with smooth welded channel-shape reinforcing around the top. The bottom is also heavily reinforced. The subframe is a stiff, strong, amply reinforced structure which distributes the load on the chassis frame and reinforces it. There is room between it and the driver's seat for an auxiliary body or box, for tools, etc.

Easton Roll-Oven Dump Body.

Simplifying the Setting of Slope Stakes

The very simple little instrument illustrated herewith does away with much of the difficulty and danger of error incident to the common methods of setting slope stakes. In essence the instrument in a board carrying a level bubble mounted on a swinging arm, adjustable to points on an arc to give the board any desired slope between horizontal and 1 to 1. As sold, it consists merely of a 5-in. by 7-in. metal plate carrying the adjustable arm, level and arc. The plate is attachable by screws to any board. The arc is provided with holes for slopes of 3 to 1, 2 to 1, 1½ to 1, 1 to 1 and level; and the arm is held as desired at any of these points by the engagement of a short pin in the proper hole.

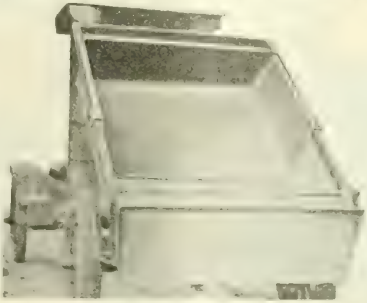


Balsley Slope Level.

The instrument is known as the Balsley Slope Level and is manufactured by the David White Co., 908-915 Chestnut St., Milwaukee, Wis.

Automatic Device for Securing Clean Dump of Wet Concrete

A new device for handling wet concrete mix in dump bodies has been brought out by the Anthony Co., Streator, Ill. It is claimed that this device, patents for which are pending, cleanly scours the sides and the bottom of the dump—every time it is unloaded—no matter what kind of sticky material is hauled—and cleans itself as well when forcibly strikes specially arranged shock stops at the body's end.



The "Scooperout" for Securing Clean Dump of Wet Cement.

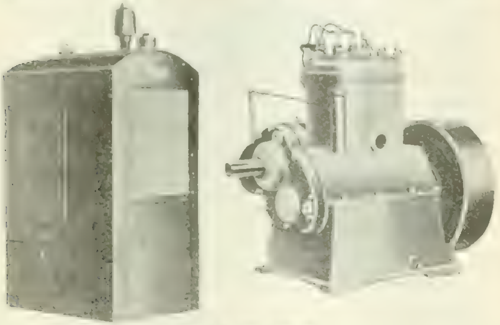
Road Show Exhibit of Equipment Direct from the Job

An innovation at the recent Good Roads Show at Chicago was the display of equipment which had seen actual service on the construction job. The accompanying illustration shows one of these exhibits.

Progress of Federal Road Construction.—A synopsis prepared by the U. S. Bureau of Public Roads shows that up to Dec. 31, $212,077,246 had been put to work in projects either entirely complete or under construction. To match that amount the States appropriated $285,379,312, making a total of $497,456,558. The total mileage of roads under construction and completed, the department's records show, was approximately 27,000 miles. Of this mileage 9,555 miles was in projects entirely completed. The balance of 17,445 miles was in projects which were still under construction but reported 69 per cent complete October 31. In those projects there was the equivalent of 12,000 miles of completed roads, so that the completed road to date was more than 21,000 miles.

New Engine for Construction Equipment

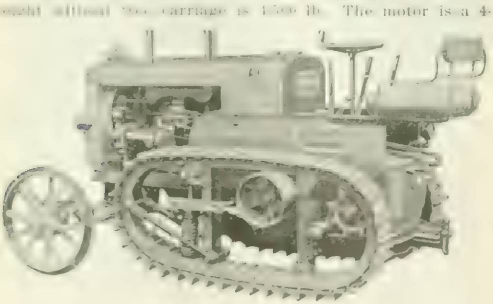
The Le Roi Co. of Milwaukee, makers of heavy duty engines since 1914, announced a new engine at the Chicago Good Roads Show. This engine is offered to the trade interested in engines developing from 4 to 8 HP. It is the vertical type, 4 cycle and 2 cylinder and with a 3½-in. bore and 4½-in. stroke. In designing this engine, the Le Roi Co. kept prominently in mind the fact that dependability is the most important feature of an engine that is to be used on contractors' equipment. Because the standard 4-cylinder engine made by this company has been giving such extremely satisfactory results, the same general characteristics and design [illegible] in the two that are found in the four. For this reason, 87 per cent of the parts used in the 2-cylinder engine are used in the 4-cylinder engine. This eliminates production problems at the factory and enables the company to market an engine at an extremely favorable price. One very novel feature of this engine is the fact that the drive may be taken off at three different points on the engine. This drive can be taken off at either the front or the rear at engine speed. However, if slower speeds are desired, the drive is taken off of the camshaft at one-half engine speed. This reduction is obtained through machine cut steel gears operating in a bath of oil and the drive shaft is mounted on ball bearings which insures dependable operation. The engine may be furnished completely equipped with all accessories including fuel tank, radiator, fan and fan belt, and in fact everything ready to run. It is fully enclosed so it may be operated on equipment without the necessity of building a house over it. Equipped and enclosed in this manner it only weighs 325 lb. This engine also may be purchased without accessories and other equipment and in this condition the engine only weighs 260 lb.



New Le Roi Engine

New Track Laying Tractor

A new tractor with track runner traction has been brought out by the Avery Co., Peoria, Ill. This tractor has a draw-bar rating of three 14-in. mold board plows or five disc plows at a speed of 2.66 miles per hour, with motor at 1,000 r.p.m. It has a length over all of 9 ft. and a height of 58 in. Its weight without [illegible] carriage is [illegible] lb. The motor is a 4-cylinder vertical type, Avery made, with 4-in. bore, 5½-in. stroke and 2¼-in. crank shaft. The tractor has three speeds: low [illegible] 1½ miles per hour, intermediate 2½ miles and high 3½ miles. The track runner has a length of 164 in.; the pads are 8¼ in. wide. The regular traction lugs and 10-in. 1½x1½ angle steel. 1½x2 or 1½x2½ may be used to meet extreme sand or mud conditions.



Avery Track Runner Tractor

Industrial Notes

Wm. Ord has severed his connection with the Lakewood Engineering Co., Cleveland, O., and is now located at 11713 Lake Ave., Chicago.

The Portland Cement Association announces the opening of two new district offices as follows: [illegible] High St., Boston, with L. T. C. Loring in charge as district engineer; [illegible] Finance Bldg., Philadelphia, with D. S. MacBride as district engineer in charge.

Laclede Steel Company, St. Louis, Mo., announces that effective Feb. 1st, 1922, W. W. Smith, Jr., formerly manager of sales in St. Louis for Carnegie Steel Co., Illinois Steel Co. and Tennessee Coal Iron & Railroad Co., will become affiliated with the company in the capacity of general manager of sales.

Bucyrus Co., South Milwaukee, Wis., with Northwestern sales office at 608 Pittock Block, Portland, Ore., announces the appointment of A. R. Hance as Northwestern sales manager, succeeding Mr. L. T. Russell, who has resigned after ten years of service with the company. Mr. Hance has been connected with the sales department of the company in the Central and Eastern territories for a period of six years.

The Parsons Co., manufacturers of trench excavating machinery, has established a branch office at 510 Railway Exchange Building, Kansas City, Mo. J. E. [illegible], of the district manager in charge of the office. An agency [illegible], also has been established with Fred S. Sawyer, 2220 Market Street, Philadelphia, Penna., who will sell Parsons equipment in that district. The Atlanta Machinery Co., 90½ North Forsyth St., Atlanta, Georgia, F. S. Truex, Manager, will market Parsons equipment in the southeastern territory.

D. B. Frisbie of Atlanta, Ga., has been given the responsibility of developing a large selling organization throughout the south for Barber-Greene Co., Aurora, Ill., manufacturers of B-G portable belt conveyors and B-G self feeding bucket loaders. He has offices at 90½ N. Forsythe St., Atlanta, Ga. The following southern sales organizations are under his direction: General Utilities Co., Norfolk, Va.; Stannard Equipment & Machy. Co., Spartanburg, S. C.; A. B. Moore, Jr., Savannah, Ga.; Alabama Machy. & Supply Co., Montgomery, Ala.; J. D. [illegible] Co., Birmingham, Ala.; Wilson, Webster & Co., Nashville, Tenn.; Leaders Coal Mining Co., Nashville, Tenn.; E. W. Price, Tampa, Fla.; Higgins & Wormington, New Orleans, La.; A. M. Lockett Co., New Orleans, La. More representation probably will be added in the near future.

The Marsh-Capron Co., Chicago, manufacturers of the Marsh-Capron line of construction equipment, are again taking up the marketing of their products with the trade. Robert C. Weller, former general sales manager of the Lakewood Engineering Co., has been elected president and will have entire direction of the newly organized company. Although the Marsh-Capron Co. has been manufacturing and selling mixers since 1905, for the past two years their output has been sold through an outside sales organization. H. M. Capron, founder of the Marsh-Capron Co., and A. D. Mosby, engineer in charge of design and production, retain an active interest in the new organization. In addition to the Marsh-Capron family of concrete mixers, the company will market mortar mixers, wheelbarrows, concrete carts, grouters, sidewalk forms, curb or curb and gutter forms, road forms, bar benders and cutters, floor finishing machines, clamshell buckets, etc., through its factory and general distributing warehouses and agencies at Chicago, Philadelphia, Pittsburgh and elsewhere.

Trade Publications

The following trade publications of interest to engineers and contractors have been issued recently:

Automatic Dump Body.—[illegible] Co., Keokuk, Ia. Circular illustrating and describing various types of dump bodies.

Graders.—J. D. Adams & Co., Indianapolis, Ind. Circular illustrating and describing the Adams adjustable leaning wheel graders.

Form Grader.—Edward G. Carr, 224 W. Huron St., Chicago, Ill. Circular describing new machine for preparing grade for road forms.

Street Flushers.—Tiffin Wagon Co., Tiffin, O. Circular containing illustrations of the types of Tiffin motor driven combination power flushers owned by various cities.

Asphalt Paving Machinery.—Barber Asphalt Co., Land Title Bldg., Philadelphia, Pa. Folder devoted to Iroquois asphalt mixing plants, steam melting kettles and rollers.

Steel Forms.—Heltzel Steel Form & Iron Co., Warren, O. An illustrated comic bulletin, entitled "Steel Forms Talk," setting forth in an amazing yet forceful manner why these forms should be used.

Motor Trucks.—Titan Truck Co., Milwaukee, Wis. Circular containing, in addition to descriptive matter and specifications, illustrations of various jobs on which these trucks were used during the past season. Many interesting construction installations are shown.

Motor Trucks.—Autocar Co., Ardmore, Pa. Booklet devoted to the use of this company's trucks in highway work. Contains a list of contractors owning these trucks. It also includes line drawings showing truck dimensions and numerous illustrations of interesting highway construction jobs.

Concrete Mixers.—Foote Concrete Machinery Co., 1241 Michigan Ave., Chicago, Ill. An excellently gotten up catalog devoted to the Multi-Foote road paver. Contains specifications and numerous illustrations of the machine and its parts including line drawings, giving dimensions. The catalog also contains views of interesting construction operations on which the mixers are being used.

Bucket Loaders on Road Work.—Barber-Greene Co., 510 West Park Ave., Aurora, Ill. Booklet describing the many new applications made during the past season of Barber-Greene loaders in the building of concrete roads. Contains descriptions of 24 jobs. In each case the methods used are described, the labor organization is given, and the average and maximum daily yardage is stated. The outlines of the jobs were obtained with the help of contractors by means of [illegible] on the ground and all figures were carefully checked with the office records of the contractors or engineers in charge of the work. The booklet contains drawings showing plant layouts for all the jobs described and numerous half tones of interesting construction views.

Waterworks and Hydraulics Monthly Issue

ENGINEERING AND CONTRACTING

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Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Managament and Office System

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The Expert Witness

It must be acknowledged, however regretfully, that the expert witness does not hold a position of the highest esteem with the public, and it must also be admitted that this condition is in large part due to the ill advised efforts of certain members or pseudo-members of the professions from which the witnesses are drawn. On the other hand there are, as we believe, certain misapprehensions even among engineers as to the proper purposes, functions and limitations of the expert.

An example of this occurred in a paper read last July before the North Carolina Society of Engineers by Mr. C. E. Waddell, from which we quote as follows: "What should be the attitude of the expert witness? Abolish him is my personal view. From my own experience I have concluded that the 'expert witness,' whether he be engineering, medical, or whatnot, is not worth the time he consumes before a jury. The expert witness is biased; both litigants, the judge and jury recognize this fact and make allowance therefor. The expert witness, in my observation, is perfectly honest, and his views are not distorted by his client's case, the client has sought and retained an expert who agreed with him, hence the presence of the witness. Let us seek the co-operation of the judiciary and the bar and endeavor to have expert witnesses selected by the court, to be the adviser to the court and as disinterested a party as is the judge or the jury. Possibly the first step would be to continue present practice and merely add the court's adviser. Eventually the present practice could be superseded and the ex parte witness abolished."

We admit the charge that few experts, however honest, are entirely free from bias in favor of their employers. The honest expert, however, will testify only to what he knows or to what he believes; and in the latter case he will leave no doubt that he is testifying to opinion rather than to fact. Concerning demonstrable facts, therefore, even though they be complex, there should be little disagreement. That this not only should be but often is actually the case our own experience has proved, for we have on numerous occasions reached a complete agreement with opposing witnesses on a large part of the most important issues of a case.

Mr. Waddell's suggestion for the employment of experts by the courts has its merits but is not a panacea—for one reason because of the difficulty of finding any man absolutely free from bias; and secondly, as we believe, because every litigant should be permitted to seek and to present all evidence whatsoever that bears upon his case.

Litigants in technical cases often themselves fail to find important facts pertaining to their cases or to draw correct conclusions from facts found; and to us it appears obvious that there is far greater danger of outright omissions when the contestant has no personal expert to perfect his case than where such services are provided. The fact that it would be the duty of the court's expert to bring to light every pertinent fact is not a guarantee that the facts would be found. The court's expert would almost of a certainty lack the eagerness of the contestant's witnesses in seeking for data, and it is scarcely thinkable that he would be as efficient or as successful as they. In fact the doing away with partisan witnesses has much in common with the doing away with partisan attorneys—a procedure which we have not heard seriously suggested.

Obviously in cases of conflicting testimony the Court's own witness would be of very special value. Still more valuable, probably, would be his services as technical advisor and consultant of the court; and until technical courts are established for the trying of technical cases such an arrangement will probably afford the best results possible. While the employment of another expert would add considerably to the cost of cases, the advantages to be gained would probably much more than offset the extra expense. Furthermore, the neutral expert might well co-operate with the partisan experts in saving considerable duplications of work, thus offsetting a substantial part of his added expense.

Mathematical Solutions of Public Ownership Problems

The economic choice between public and private ownership of a public utility can sometimes be determined mathematically. In other cases, although positive solutions appear to be impossible, mathematical studies will often provide strong indicators to supplement, or even to take the place of the less exact methods usually employed. General appreciation of these facts will go far toward securing the most beneficial results in such cases, toward simplifying and expediting decisions and toward the elimination of useless wrangling.

In our issue of December 21, 1921, we commented upon the fact that because of its better position as a borrower, the public can usually finance the cost of property more cheaply than can the private corporations; but that on the other hand, public operation is usually more costly—often very much more costly—than is private operation, and no experience of which we have a record has developed means for overcoming this general inferiority. Rarely an apparent exception appears when a new superintendent takes charge; but almost always the "new broom" either loses its efficiency quickly or is thrown out of office on account of politics. Our suggestion on December 21 was that a combination of public ownership and private operation might afford the best solution of the problem, and should be given consideration. Such an arrangement, however, would take time to develop, and would require testing. Decisions in many cases could not wait for the complete development of a system—much less upon the outcome of an experiment—whence the present importance of the use of every possible assistance toward a wise choice between the private corporation and the public as both owner and operator.

In any given case there can be reasonably accurate predetermination of the interest rate which would be required respectively of the municipality or of the corporation upon the investment in plant property. As a convenient and reasonable illustration let us say that the city can get the money at 5 per cent and that the company will probably be granted a fair return rate of 8 per cent to cover both interest and profit.

If operating expenses under the two classes of administration could be determined with the same certainty as interest, most of the problems would be completely and accurately soluble. As it is, it is often difficult to get any satisfactory comparison whatever between the two; while under the most favorable circumstances approximate comparisons only are possible.

Street railway properties present the worst cases, for their operations are the most complicated of all the utilities, and there are so few under municipal operation that it would be exceedingly difficult for most cities to find a case of public operation under operating conditions closely similar to its own. Gas plant operation is simpler, and in some localities, comparable cases are less rare, but throughout the country at large there are few opportunities for satisfactory comparisons. Municipal electric light and power systems are much commoner, and careful search and analysis will often bring out very reasonable comparisons. Municipal waterworks are the commonest of all and also the simplest and cheapest in operation. For satisfactory comparison and estimate it is necessary to have records of public and private plants in communities of somewhat similar populations, area, physical conditions and business conditions.

Cases involving waterworks are most often subject to accurate determination, partly because there are more comparative figures of publicly and privately operated plants, but more because the proportion of operating expense to interest charges is smaller in this class of properties than in any other. For illustration consider a utility property the plant cost of which is $1,000,000 to either public or private owners. This is an assumed condition that need lead to no confusion. It is true that plant costs are often much greater to the public than to private concerns, that extravagance is more common and that pretentious but uneconomic projects are much more likely to be undertaken, but these circumstances are neither invariable nor unavoidable. We therefore, for present purposes, use the simple case of equal plant costs. If, in a particular instance, there is valid reason for considering a difference in plant costs, such difference can be recognized in the calculations.

Interest paid by the public will be taken at 5 per cent; interest and fair return on a private plant will total 8 per cent. Taxes on the private plant are omitted from the calculation as merely passing through the corporation's hands from its customers (a portion of the public) into the public treasury. In Case A, the annual operating expenses of the private plant are $35,000, and it is estimated, though not positively known, that under public operation the expense would be $45,000. Also it is considered that by no reasonable chance will the expense of public operation exceed $55,000. The annual cost of the private plant is then as follows:

Fair Return $1,000,000 at 8 per cent	$ 80,000
Operating Expense	35,000
Total	$115,000

Under the worst conceivable conditions, the city's annual cost would be:

Interest $1,000,000 at 5 per cent	$ 50,000
Operating Expense	55,000
Total	$105,000

From this it is evident that the customers will be saved at least $10,000 per year through municipal ownership of the plant, and if expectations are realized they will save $20,000. There remains no reasonable question of the desirability of municipal ownership.

In Case B consider a utility of a different class, having as in the first case, a plant cost of $1,000,000 but an operating expense of $100,000 under private operation, a prospective expense of $150,000 under public operation, and a possible maximum of $200,000 under the same. The annual cost of the private utility is:

Fair Return $1,000,000 at 8 per cent	$ 80,000
Operating Expense	100,000
Total	$180,000

Under anticipated conditions of public ownership and operation the cost would be:

Interest $1,000,000 at 5 per cent	$ 50,000
Operating Expense	150,000
Total	$200,000

Under the worst condition it would be:

Interest $1,000,000 at 5 per cent	$ 50,000
Operating Expense	200,000
Total	$250,000

This case involves an anticipated loss of $20,000 per year through municipal ownership, and a possible loss of $70,000. Only in the event that the public can operate its plant for $130,000 per annum, will it reach a stage of economy equal to that of private operation. Its annual cost would then be:

Interest $1,000,000 at 5 per cent	$ 50,000
Operating Expense	130,000
Total	$180,000

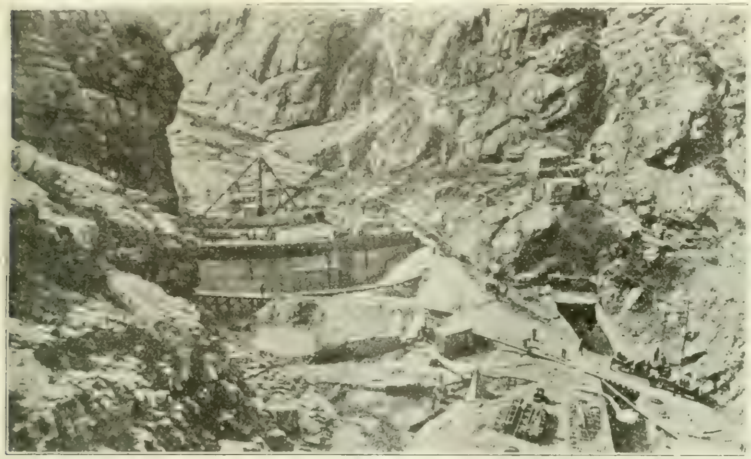
If the city can lower its expenses still further it will save money, the practical limit to this saving being that resulting from an operating expense no greater than the private expense. This would involve an annual saving of $30,000.

To summarize Case B: Municipal ownership and operation involve an anticipated loss of $20,000, a possible loss of $70,000, and a possible saving of $30,000 per annum. Under such circumstances the only reasonable policy is to keep to private operation.

What is here illustrated is only an outline. In any given case there should be detailed studies of all the factors and circumstances, and the calculations would of necessity be complicated. But the approach to municipal ownership problems on such a scientific basis will work far more economic settlements for all concerned than do the usual hot air political methods.

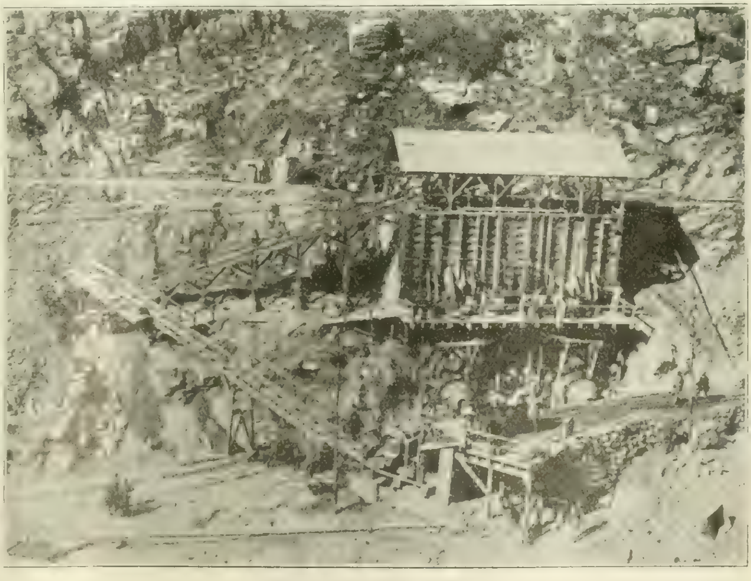
Construction Features of Hartebeestpoort Dam of South African Irrigation Department

The Hartebeestpoort Dam is the only irrigation scheme of any size being carried out departmentally by the South African government itself at the present time. The dam is located in a poort in the Magaliesberg Range through which the Crocodile River cuts its way about 25 miles from Pretoria on the Rustenburg Road. It is being built by the Union Irrigation Department for the conservation of irrigation water and will feed two canals approximately 30 miles long, one on each bank of the river, supplying water to 30,000 acres of excellent land, of which 2/3 is owned by the government.



View of Work Taken Sept. 8, 1921.

We are indebted to the South African Irrigation Department for the following details regarding the construction of this dam:



The Concrete Mixing Plant.

General Features of Dam.—The dam is of the constant angle arch type and will have a total height of 198 ft. above lowest foundation where it is 72 ft. thick. The depth from bedrock to river bed level varies from 25 to 35 ft. The width of the poort at river level is 150 ft., but the crest length of the dam will be 450 ft. with a width of 15 ft. over which the main road to Rustenburg will pass. At the crest the radius of the arch is 225 ft. to the downstream face.

On the left flank a trough spillway, 125 ft. wide on the line of the dam and 415 ft. long, is being excavated to deal with the maximum probable flood; the spillway will be bridged to carry the main road from the dam.

The flow of the Crocodile at the poort varies from 40 cusecs in the winter to 200 in the summer, with floods up to 12,000 cusecs fairly frequently and as high as 140,000 cusecs on occasion. As winter floods are rare and have seldom exceeded 600 cusecs, the diversion works were designed to cope with that flow during the low-flow period from May to September, large floods being unknown before October.

Work is being carried out entirely by white labor and was commenced in 1918 when a light railway, 9 miles long was laid from the Works to Brits West, a siding on the Pretoria-Rustenburg line. At the same time quarters, offices, workshops and power plant were laid out. Lack of working space in the poort led to the adoption of electric power and two Bellis and Morcom sets, with a third one added later as a standby, supply power at 2,200 volts which is transformed down to 500 volts for use.

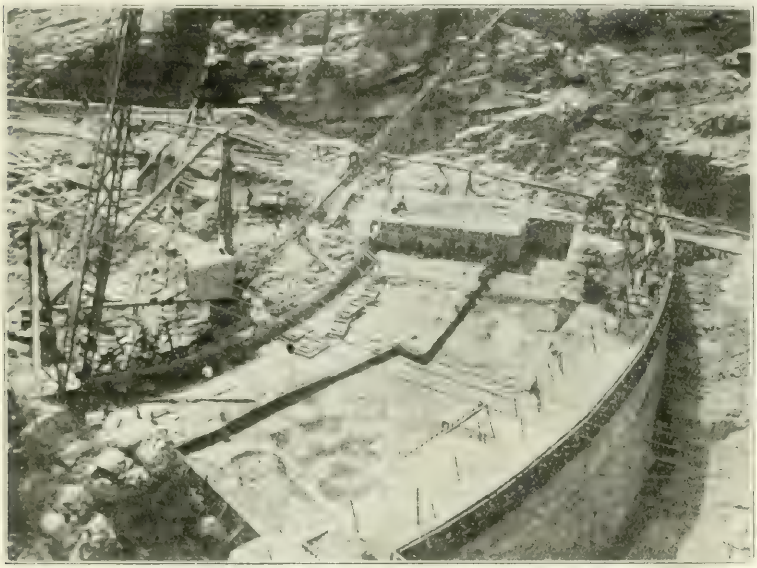
The Coffer Dam.—To enable the work of placing the foundations to be accomplished in the dry, two curved concrete coffer dams were started. After the upstream dam was completed by divers, it was discovered that solid rock had not been reached. The downstream coffer dam was, therefore, carried down to boulders only. A second diversion rockfill weir was built above the upper concrete diversion dam. It was decided to tunnel through the right bank and completely divert the river through the tunnel. The tunnel which is 240 ft. long, 12 ft. wide, and 6 ft. deep with a grade of 1 in 200, was worked from both ends, the headings meeting after 6 weeks. The river is led into the tunnel from the rockfill diversion weir, by a short concrete approach flume also 12 ft. x 6 ft. and at the outlet another short length of concrete flume delivers the water into a corrugated iron flume, supported on timber piles, which takes the water well clear of the site.

The Diversion Weir.—The construction of the diversion weir was commenced early in May, 1921, when the tunnel and most of the inlet and outlet fluming was almost complete. Nine in. x 3 in. planks were driven into the sand and gravel to form close piling which was backed by rockfill and faced with a clay blanket which was carried 60 ft. upstream along the river bed to reduce seepage.

The river was diverted entirely on May 24 and excavation commenced in earnest. The leakage through the weir was inconsiderable and easily dealt with by an 8 in. centrifugal pump. A 10 in. sand pump was installed as a standby but was never called into use. By this date a commencement had been made with the erection of the concreting plant.

During this critical period, labor troubles were at their worst and at times the wastage exceeded the supply of fresh labor. The men were restive and unsettled, and this unrest held the work up considerably and threw a large burden of unproductive overtime upon the staff.

The material in the river bed was mainly sand, gravel being reached at a depth of 15 to 20 ft., although under the left bank a number of boulders, ranging in size up to 30 cu. yd., had to be broken up before removal.



View Taken Sept. 8. Thickness of Dam at This Level Is 60 Ft.

The Excavation.—Before the diversion of the river some preliminary excavation of sand was done by two 6-in. sand pumps mounted on barges. Just prior to the closure of the diversion weir one of these pumps was moved upstream, but the other was left to assist in the dewatering of the foundations, sinking with the water surface until it was left high and dry at the end.

A 5-ton crane was erected on each bank to command the greater portion of the excavation. Grab buckets of 2 3 cu. yd. capacity were used with these cranes for a short time but it was found the cranes would not stand up to the heavy work and a graded wire-rope haulage which was installed subsequently successfully dealt with the 8,000 cu. yd. of material that was removed. The material was all lifted by hand into "Cocopans" and run out direct, the maximum weekly output being 2,300 cu. yd.

Two 6-in. centrifugal pumps (additional to the 8-in. pump behind the weir) were installed to keep the excavations dry from the seepage which came back from the river below the lower coffer dam. These were successful, although the greatest difficulty encountered was to keep the sumps below the general level of the excavation. By the middle of July rock was exposed over the whole area. It is a somewhat seamy quartzite, the bedding planes dipping downstream at approximately 20 degrees. It is rather fissured on the flanks, but generally good on the bottom except for some dykes of basic igneous rock (lamprophyre) which weathers remarkably rapidly, and some small faults. All these were followed up and thoroughly cleaned down before concreting commenced. The major portion of the rock required very little stopping except on the flanks, thorough scrubbing sufficing before concrete was placed. A "cut-off trench," 6 ft. wide and from 5 to 10 ft. deep was excavated right across the poort just at the upstream face of the dam wall.

On July 29th work was sufficiently advanced to commence placing concrete.

It had been found impossible to erect, in the short time available, the concreting plant in such a position as to command the dam during its whole construction, and in order to bring the wall above river-bed level during the short period before summer floods could be expected, a purely temporary lay-out had to be adopted on the right bank low down in the poort itself at a height just sufficient to command the wall up to the required river level. A quarry was opened at the back of a large boss of rock known locally as the "Pimple" from which the rock was allowed to roll down the hillside for tramming to the crushers, whence a conveyor belt raised it to the main bins above the mixers.

Sump Method of Securing Sand for Aggregate.—Sand-collection proved a difficulty at first, but the problem was solved by a method, which, at first in the nature of an experiment, was found to work wonderfully well. A sump, consisting of a section of 4 ft. diameter concrete piping, was sunk close to the spoil dump of the sand removed from the excavation. The suction pipe of a 6 in. sand pump was inserted into the sump near the base; water was syphoned into the sump through a 6-in. pipe from the adjoining flume and sand was shoveled in through a screen. The pump delivered the sand through some 600 ft. of piping to a sandbag dam, near the mixing plant where the water was allowed to drain off. From this dam the sand was lifted by cranes to temporary storage bins of 150 cu. yd. capacity, when it was trammed to the main bins.

Cement was brought to the bins by a one-ton cableway from the main store on the left bank. This cableway was also of value for the general transport of materials to the river bed.

The Concreting Plant. The concrete mixing plant is in two complete units, each consisting of rock, sand and cement bins from which the materials run through gates into adjustable measuring boxes from which they pass to the mixer through a chute. The gates from the measuring boxes to the chute are operated by compressed air.

As the materials pass into the mixer, of 1 cu. yd. capacity, a measured quantity of water is added. The mixers tip direct into 1 cu. yd. capacity cocopans which are hand trammed to the wall. All the concrete was placed by the two 5-ton cranes which, re-erected in commanding positions, lifted the pans off their frames, and tipped them into the wall. The whole of the concreting plant was designed on the works and the results obtained have been extremely gratifying.

Concreting Operations.—It was decided first to carry the front section of the dam some 20 ft. wide up to 6 ft. above river bed so that in case of a bigger flood than 600 cusecs the upstream rockfill weir would not have to be renewed. Two 8-hour shifts were worked on concreting from 7 a. m. to 11 p. m. with a night shift from 11 to 7 doing any cleaning up necessary to give the morning shift a clean start. A bonus system was instituted based on the yardage placed and this roused keen competition between the two shifts. The limiting factor was the quarry. Rock could not be supplied as fast as the mixers demanded it, but nevertheless excellent results were obtained, the maximum outputs of concrete being 40 cu. yd. per hour, 429 per day and 2,060 per week. The narrow front wall grew at such a pace that trouble was experienced with the shuttering and the remainder of the dam was carried up as a whole.

On Sept. 7th the task aimed at was accomplished and with a total of 9,500 cu. yd. placed the whole wall was 6 ft. above river bed level. Plenty of time before floods was still on hand and consequently additional concrete was placed, a wall 10 ft. high being carried up along half of the front face of the dam and a 5 ft. wall along the remainder of the face, thus enabling work to be carried on over one-half should a flood too great for the tunnel come down and overtop the lower portion of the well, when concreting is recommenced in December.

How a Water Company Co-Operates with Water Uses

The Terre Haute Waterworks Co. of Terre Haute, Ind., of which Don Gwinn is President and manager, has established an enviable record for progressiveness in dealing with its customers. An example of excellent co-operation with the water user is shown by a folder issued last fall at the commencement of the cold weather season. This folder was sent to all water users of the company. The folder contains the following suggestions:

TO THE OCCUPANT.
(Address)
Terre Haute, Ind.

Please hang up this card for future reference. The information given if followed may save you annoyance and expense.

Cost of high-grade water in Terre Haute is kept down by large production, reduction of waste and efficient operation with economical machinery.

At least six tests of the filtered water are made daily. Weekly reports are made to the State Board of Health, and the state officials make inspections of our plant without notice.

SUGGESTIONS TO WATER CONSUMERS.

How to Shut Off Water—The "shut off" known as the stop and waste, where the pipes enter the basement (and also on the vertical pipes), is your immediate protection in the event of a burst pipe and also for the purpose of shutting off and draining the house pipes where and when there is danger of freezing; it should be easy of access and in good condition. In some basements it is covered with coal, or it is in such bad condition that it cannot be turned. The man of the house should see that the stop and waste is in good order and that the folks at home know how to operate it. To shut off, turn handle so that it is at right angle with the pipe, a one-quarter turn.

Sill Cocks for Sprinkling—Sill cocks or hose faucets on the side of the house should be shut off in the basement before freezing weather, and when this is done, the faucet should be opened so as to admit air, which will cause the water to run out at the stop and waste in the basement. This procedure should be followed when it is desired to drain the house pipes. Air must be admitted at the top to force the water out below.

Frozen Pipes and Hot Water Troubles—If pipes are frozen, they may be thawed, in some cases, by wrapping cloths around them and pouring hot water on. Do not use a torch for thawing pipes. Do not pour hot water on the meter; do not build a fire on the meter, as it will ruin the rubber piston and celluloid register and a charge is made for repairing the same. If water in range (hot water) boiler is allowed to get very hot either from furnace fire or gas heater, there is danger of forcing the hot water back into the meter, causing serious damage. All cost of repairs to meters damaged by heat is charged to the consumer. As there are comparatively few cases of this kind, the person responsible for the damage should pay for it instead of putting the cost on the rest of the consumers.

If there is a bad case of frozen pipes, or if a house is to be closed for the winter, it is best to secure the services of a competent plumber. Sewer traps and range boilers should be cared for when the house is without heat in the winter.

Water Closets—Water closets should be examined frequently in order to keep the consumption of water on a normal basis. After a closet has been flushed and the tank is filled there should be no movement of water in the bowl; if there is, water is wasting into the sewer.

By holding a piece of paper or card board against the rear portion of the bowl, a flow may be detected which an ordinary examination would not disclose. There is one type of closet, known as the Syphon Jet, that will leak without disturbing the water in the bowl.

For further information, call office telephone, Wabash 217 during the day. After 6:00 p. m., or on Sundays, call Pumping Station, Wabash 213.

We are trying to make your water service as near perfection as possible.

THE TERRE HAUTE WATERWORKS CO.

November, 1921.

Loose Leaf System for Field Maps and Notes

A system that permits both field maps and notes to be carried in the same container is described by Mr. John L. Rich in Economic Geology. The system, which Mr. Rich has found to have many advantages, consists of a 5 by 8 in. clutch binder, preferably hinged only on the front cover and opening along the 5-in. side; one or more loose-leaf binders for 5 by 8 in. paper, punched along the 5-in. side; and a supply of loose-leaf co-ordinate paper, ruled into 1/6-in. squares (1/10-in. squares perhaps would serve as well). The binder fits readily into the pocket, preserves the maps from the wear and soiling to which field-maps are usually subjected, and permits ready cross-reference between maps and notes without burdening the former with reference marks. Both maps and notes may be assembled in permanent loose-leaf binders, and classified and arranged in any way the engineers may desire.

When one of the U. S. Geological Survey topographic sheets is being used as a base-map, the map is first cut into nine sections along the parallels and meridians. These sections fit readily into the note-book. Each section is mounted on a sheet of ruled loose-leaf paper in such a way that the top and left-hand sides coincide with ruled lines on the paper. Glue or rubber cement may be used for mounting. The latter has the advantage that it does not cause buckling and is not affected by water.

The sections of the map are designated by an initial letter or abbreviation for the name of the sheet and a number for each of the nine sections, numbered from left to right from the top down. Thus the upper right-hand section of the Atoka sheet would be "A-3." The lower left-hand section would be "A 7." This designation is placed at the lower right-hand corner of the sheet. On the side margins of the loose-leaf sheets, outside the map, the squares of the cross-section paper are numbered from the top down. Only every fifth number, 1, 5, 10, etc., is actually set down. This furnishes one of the co-ordinates for locating positions on the map. The other is furnished by a "cover-sheet," which is simply a blank sheet of the co-ordinate paper, along the bottom of which the co-ordinate squares are lettered from left to right, beginning about as far from the left-hand margin as is the left-hand edge of the map.

The sheet carrying the section of the map to be used is placed in the front of the binder, with the cover-sheet over it. The notes may be kept in the back of the binder, together with sections of the map not in immediate use. To make reference to a location on the map it is only necessary to slip the cover-sheet up until its lower edge is on a point desired and is parallel to the lower edge of the map. Then, if the zero of the letter of the cover-sheet be placed at the left-hand margin of the map, the co-ordinates can be instantly determined.

The location is recorded in the notes as "A 3, 10 j," "A 7, 26 p," etc. This gives the location to the nearest 1/6-in. square without making any mark upon the map. If closer location is necessary, a dot on the map may be used. Even a small dot can readily be found at any time by reference to the co-ordinates of the imaginary square in which it occurs. In the office, the location of any point referred to in the notes can be found instantly, even on uncut map, by lettering and numbering a card to correspond with the co-ordinates that are used in the field and by using the parallels and meridians as guides for the various sections.

Garbage Reduction at Indianapolis, Ind.—The cost of reducing garbage at the municipal garbage reduction plant of Indianapolis, Ind., in 1921 was reduced $2.70 a ton from the 1920 average cost, but this saving in expense was practically wiped out by reduced prices of by-products sold from the plant, according to the annual report of the operations of the board of sanitary commissioners. Greatly reduced prices on grease and tankage, the commercial output of the garbage plant, in 1920 caused a deficit in the operation of the plant of $33,736.96, the report pointed out. In 1921, the deficit was $30,451.51. Until 1920, abnormally high prices for these by-products had made it possible to operate the plant at a profit. In 1920, it is set out, 15,367 tons of green garbage were reduced at a cost of $6.50 a ton. In 1921 the total amount of garbage reduced was increased to 20,033 tons, and the cost a ton reduced to $3.80. The saving in expense was estimated at $24,824.

Kutter's Formula Simplified

By H. E. BABBITT
[illegible] Professor, Municipal and Sanitary Engineering, University of Illinois

Kutter's formula is more commonly used in the solution of problems of flow of water in sewers or open channels than any other hydraulic formula. The extended use of the formula has been due to the confidence placed in it by engineers because of the many investigations of its accuracy, and possibly because of the wide publicity given to it and the availability of many diagrams for its solution. The popularity of the formula is certainly not due to its simplicity because it is one of the most cumbersome of all hydraulic formulas. It is a monument to the mathematical ingenuity of the men who produced it.

Kutter's formula is commonly expressed in English units as:

$$V = \frac{\dfrac{1.81}{n} + 41.67 + \dfrac{.0028}{s}}{1 + \dfrac{n}{\sqrt{R}}\left(41.67 + \dfrac{.0028}{s}\right)} \sqrt{RS} \quad \ldots\ldots 1$$

in which

V = velocity of flow in feet per second;
n = roughness coefficient of material of conduit;
R = hydraulic radius of conduit, in feet.
S = slope of the hydraulic gradient.

This is a modification of the Chezy formula, $V = C\sqrt{RS}$ in which allowances are made of the effect of n, R, and S, on the value of the coefficient C. The value of S was introduced into the coefficient, to allow for the low slopes studied in the Mississippi River investigations.

In ordinary problems met in the design of sewers, drainage ditches, and other small open channels, the discrepancy between the value of V as found with Kutter's formula as quoted above, and the value of V found by omitting the term $\frac{.0028}{s}$ is negligible. The difference is less than that caused by the selection of the value of n one thousandth above or below its true value. If this term is omitted the formula can be rewritten as

$$V = \frac{(1.81 + 41.67\,n)\ \sqrt{R}}{n\sqrt{R} + 41.67\ n^2} \sqrt{RS} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

A comparison of the results obtained by the use of these two forms of the expression shows that for ordinary conditions of design the discrepancy between the two forms is insignificant. For all slopes greater than 1 in 1,000 for 8-in. pipe, with a value of n = 0.015, the discrepancy is less than 1 per cent. For larger channels with the same slope and coefficient of roughness, the discrepancy decreases up to a channel with an hydraulic radius of 3.28 ft., at which figure the values of V are the same for both expressions, regardless of the value of the slope. For channels with an hydraulic radius greater than 3.28 ft., the discrepancy increases with an increase in the hydraulic radius. A decrease in the slope will increase the discrepancy. For a channel with an hydraulic radius of 4 ft., a value of n = 0.015, on a slope of 1 in 1,000 the discrepancy is less than 0.1 per cent, but for the same channel on a slope of 1 in 10,000 the discrepancy is 1 per cent. The results of some computations of the values of C by the use of the two expressions are shown in Table I. The small differences between these results for ordinary conditions are clearly shown.

The columns, in the Table, headed C and C_2 refer to the coefficient C as determined by the original and the modified forms of Kutter's formula, respectively. Since the apparent discrepancies introduced by the use of the modified form of the formula for the solution of problems ordinarily met are less than the discrepancies introduced by a difference of .001 in the determination of the value of n, the use of the simplified expression is justified.

Commission to Determine Plans for Colorado River Development

President Harding has appointed Secretary Hoover as Federal Chairman of the Colorado River Commission recently created jointly by Congress and the seven states traversed by the river. The appointment has been made with the approval of the governors of the states concerned. The creation of this commission is the first step in what promises to become one of the greatest of our national improvements, involving over a term of years an expenditure of several hundred millions of either public or private funds. The States of California, Arizona, Nevada, Utah, Colorado, Wyoming and Montana are interested in the irrigation and power to be derived from the river and considerable conflict has already developed.

The land under irrigation in 1920 from the river and its tributaries amounted to about 2,464,000 acres in the United States and 190,000 acres in Mexico. If the river were equipped with proper storage dams the amount of irrigated land could be increased to about 6,123,000 acres in the United States and 800,000 acres in Mexico.

There is practically no power developed on the river at the present time, but it has possibilities of developing 6,000,000 H.P. as an incident to development of irrigation storage. Some of this horsepower is urgently needed at the present time in Southern California and Arizona.

One of the large problems of the river is the constant threat of the lower river to break through its banks and to flood the Imperial Valley, where something like $100,000,000 work of property is at stake. Such a break occurred a few years ago and it cost several million dollars to restore the river to its normal channel.

In order to secure a definite control of the flood waters and systematic development of its power possibilities and give maximum storage for irrigation, the river must be considered as a single problem in the interests of all the states and the nation. If such a co-ordinated long-view plan is worked out it is anticipated that enough water will be available for all the land available to the river and enough power for all the community.

It is the duty of the commission to determine a plan for such development and to make recommendations to Congress. A number of private concerns are anxious to undertake the development of the power and water.

Illinois Section Am. W. W. Assoc. to Meet at Urbana.— The 14th annual meeting of the Illinois Section of the American Waterworks Association will be held in Urbana, Ill., on March 23 and 24. G. C. Habermeyer, Urbana, Engineer State Water Survey, is secretary.

TABLE I—VALUES OF C AS DETERMINED BY KUTTER'S FORMULA IN THE ORIGINAL AND MODIFIED FORMS

	Hydraulic Radius 0.1 feet			Hydraulic Radius 1.0 feet			Hydraulic Radius 3.28 feet			Hydraulic Radius 4.0 feet			Hydraulic Radius 8.0 feet		
[illegible]	C	C_1	% error	C	C_2	% error.	C	C	% error	C	[illegible]	% error	C	C_2	% error.
[illegible]															
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11.5	181	181	000	187	[illegible]	[illegible]	207	[illegible]	6.4
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	157	6.4	181	181	000	186	[illegible]	[illegible]	201	[illegible]	3.5
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.71	181	181	000	185	[illegible]	[illegible]	195	194	0.26
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	157	[illegible]	181	181	000	184	184	0.05	194	194	0.05
[illegible]															
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	72.1	13.2	90.6	90.6	000	95.2	[illegible]	[illegible]	111	[illegible]	8.4
[illegible]	[illegible]	[illegible]	[illegible]	66.9	[illegible]	7.8	90.6	90.6	000	94.4	[illegible]	1.18	107	[illegible]	4.9
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	72.1	[illegible]	90.6	90.6	000	93.5	[illegible]	0.22	102	102	0.59
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	72.1	000	[illegible]	90.6	000	93.3	[illegible]	000	102	102	0.01

[illegible] show discrepancies less than 6 per cent. These discrepancies are the least that would be caused [illegible] the value of n.

Methods of Blasting Drilled Wells to Increase Flow of Water

Shooting oil wells by exploding a charge of nitroglycerin in the well to increase the flow of oil is a common practice throughout the oil fields, and the methods are well established. Various torpedo companies, as they are called, make a business of sending experienced blasters to the oil operators with the necessary explosives and accessories. Within recent years explosives have come into use for increasing the flow of drilled water wells. An interesting outline of the methods of doing this that has been found practical in many instances is given by Mr. S. R. Russell, Technical Representative of E. I. du Pont de Nemours & Co., Inc., in the November-December issue of The Du Pont Magazine, from which we have taken the matter that follows.

Careful Study of Conditions Should Be Made.—The methods of blasting drilled water wells are much the same as those employed in the oil fields, but the desirability of blasting such a well should first be determined by careful study of its location, its drilling record, and the water supply it is designed to draw upon. While oil wells are usually located in segregated districts at some distance from a town, the drilled water well may be near a farm-house, in the town itself, or even, as in one case concerning which we were consulted, in the cellar of a metropolitan hotel.

Whether it is safe to blast depends largely upon the proximity to buildings and the depth of the well. If the well is in a city close to or within large buildings, it may be dangerous to blast, lest the shattering of the rock underground weaken the foundations of the buildings, or flying fragments of rock do damage above ground. If the well is shallow, any risk there may be of injury to surrounding property is increased. However, wells within a few feet of houses have been blasted without the slightest damage and it is probably safe to say that if the size of the charge is proportioned to the depth of the well and the work is carefully done, blasting can be carried out in most places with little risk.

Whether it will be profitable to blast a drilled water well depends upon the quantity of water in the earth or rock surrounding the borehole, and the character of the formation. The U. S. Geological Survey has made studies of underground water supply in most sections of the country and can furnish maps and other information concerning the depth, abundance and composition of underground waters and the character of both the water-bearing strata and the strata between them and the surface which will be found of great value alike in selecting the well location and drilling the hole and in blasting to increase the flow of water.

Blasting in Wells in Sand and Water-Bearing Rock.—If a well is sunk into sand or gravel it generally produces water in direct proportion, first, to the quantity carried by the strata, as the water moves freely through all portions of such material, and second, to the angle of the strata, the steeper the dip of the water-bearing strata toward the bottom of the hole, the greater always the pressure and, consequently, the rapidity with which the water will rise in the hole. Firing a blast at the bottom of a well in sand or gravel would have practically no effect on the flow of the well; the sand or gravel would simply settle back after the explosion into its original place in the porous mass

If sunk into water-bearing rock, however, a well may draw only from the particular pores or crevices which it intersects and their tributary pores and fissures, and thus secure only a relatively small portion of the water carried by the whole stratum at that point. If passages could be opened into the borehole from the whole area of the surrounding rock, the flow of the well would be immediately increased. Here, therefore, is the function of explosives, for a heavy charge fired at the bottom of the well would increase the sectional area of the hole, making a collecting cavity for water, and would open up radiating fissures throughout a considerable area of the enclosing rock.

Methods of Blasting and Size of Charge.—The methods of blasting drilled water wells are derived directly from oil-well shooting. The explosive is usually placed at the bottom of the hole. If a record of the hole has been kept by the driller, as should always be done, showing the kinds of material encountered in drilling, the depth and thickness of each successive layer and the point or points at which a water-bearing stratum was struck, this should be consulted by the blaster before deciding the location of the charge. It sometimes happens that a hole is drilled through a water-bearing area into a lower dry area and in such a case the shot should be fired, not at the bottom of the well, but at the level of the water-bearing rock.

Inasmuch as the greatest possible fracturing of the rock is desired, it is advisable to use a quick, powerful explosive and a heavy charge. The exact size of the charge is governed by the depth of the well, the nature of the rock to be blasted, and the proximity to buildings. For a well 100 ft. deep an efficient and safe charge would be from 100 to 200 lb. of solidified nitroglycerin or from 150 to 300 lb. of 60 per cent straight dynamite. For every additional 100 ft. this loading could be increased by about 100 lb.

The Cartridges and Method of Placing.—The cartridges are carefully packed in a cylindrical shell (Fig. 1) ranging usually from 3 to 5 ft. in length, made of tin or galvanzed iron drawn out to a point at the lower end to prevent it from catching in its descent down the hole, open at the upper end and provided with a wire handle or bail. Such a container can be easily made from an ordinary stovepipe. It should always be at least an inch smaller in diameter than the borehole. If there is standing water in the hole, as is usually the case, and the hole is of considerable depth, there should be an opening in the lower end of the shell, as shown in the illustration, so that the water may pass through the shell and equalize the pressure on the explosive.

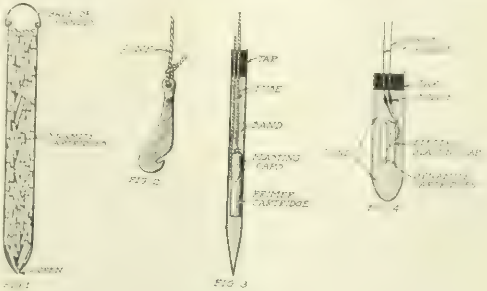


Fig. 1-4—Cartridge, Special Hook and Squibs.

When the shell is loaded, the bail is placed over a special hook (Fig. 2) on the end of a stout line and the shell is slowly lowered down the hole. By a few motions of the line the hook can then be freed and drawn up. In shooting a very deep well, several shells may be necessary to hold the required charge. If so, they can be lowered successively and one allowed to rest on another. In case a charge is to be located at some distance up the hole instead of at the bottom, a shell provided with an anchor tip is used, that is, a tube about 1¼ in. in diameter projecting a few inches from the lower end. A tin pipe long enough to reach to the bottom of the well is securely fitted over this tip and lowered into the hole ahead of the shell to serve as an anchor for it.

How the Charge Is Exploded.—The charge being seated, the next step is to explode it. This can be done by either the jack-squib (Fig. 3) or the electric squib, (Fig. 4) both devised originally for oil-well shooting.

The jack-squib consists of galvanized pipe about 2 in. in diameter and 36 in. in length, pointed at the lower end, which is filled as follows: Sand is poured into the pipe to a depth of about 6 in.; a cartridge of 60 per cent straight dynamite, primed with two No. 8 blasting caps and two fuses, is seated on the sand, and more sand is poured in until it fills the space around the cartridge and covers it to within four inches of the top of the pipe. This remaining space is then filled with thick tar. As soon as the squib is prepared, both fuses are lighted, two being used in case one should fail, and the squib is dropped into the hole, point down. The length of the fuse should be so calculated that the squib will explode about the time it strikes the charge and thus detonate it.

The electric squib of the oil-well shooter is similar in construction to the jack-squib, but shorter and larger in diameter with a less sharply pointed end. It is usually about 5 in. in diameter and 20 in long. It is filled to a depth of about 6 in. with sand and then a primer charge consisting of from one to three cartridges of 60 per cent straight dynamite is placed in the sand, one of the cartridges having been previously primed with a No. 8 submarine electric blasting cap. To the wires of this cap, at a point that will come well within the squib shell, are spliced No. 14 gage copper wires long enough to reach to the bottom of the hole, and the splices are well taped. The remaining space is filled with sand topped with a layer of tar. This squib is carefully lowered by the wires until it rests upon the charge and is then fired by means of an electric blasting machine.

If the well has struck water there will probably be some standing water in the hole. Every foot of water in the hole exerts a pressure of 434 lb per square inch. Consequently a column of water 100 ft. high over a charge of explosives exerts a pressure of 43.4 lb on every square inch of the area of the charge. It is this pressure which makes it necessary to protect the detonator from moisture by placing it in a sand-filled and tar-sealed metal shell. As the pressure may tend to force out the nitroglycerin from the cartridges, it is important to fire the shot as quickly as possible after loading. All preliminary preparations such as removing objects within danger and notifying people should be completed before the explosive is lowered into the hole so that no time need be lost thereafter.

How to Prevent Casing from Collapsing.—Most drilled wells contain a casing throughout a part or the whole of their depths; that is, a closely fitting iron pipe which has been inserted either to prevent sand, gravel or shale walls of the bore hole from caving or to shut off from the well seppage from water-bearing strata nearer the surface than the strata being drawn upon, which is apt to be polluted with organic matter. Exploding a heavy charge at the bottom of the well is likely to damage this casing, either blowing it out in fragments, which may do harm if allowed to fly into the air, or causing it to collapse within the borehole, or splitting it longitudinally along the seam.

To prevent the casing from flying into the air it is well to build a heavy grill work over the mouth of the hole. This should be securely anchored to the ground. It is hardly possible to prevent splitting the casing, but this is not necessarily a serious result, for a casing that is merely split can easily be pulled out and replaced.

If the casing collapses, however, it is more difficult to remove. In a well 300 or 400 ft. deep there is less likelihood that the casing will be blown out or split than in a shallower well, but there is danger of collapse whatever the depth of the well. To prevent the casing from collapsing, the hole should be either full of water to the top or empty of water for 50 ft. below the bottom of the casing. This last would mean that the hole was cased through only a part of its length and that the explosive charge was seated at least 50 ft. below the casing. Suppose, for example, a well 100 ft. deep containing 50 ft. of casing from the surface down and 75 ft. of water. The explosion of the charge would probably cause the casing to collapse at the surface of the water. If the top of the water column was a few inches or a few feet below the casing, the collapse would probably occur at the bottom of the casing. If, however, the water was 50 ft. below it, there would probably be no collapse at all. So it is advisable before firing either to fill the hole full of water or to bale it out to a point 50 ft. below the bottom of the casing.

Well blasting is neither difficult nor dangerous, and it has been found very successful in numerous instances in increasing the flow of water. Under ordinary conditions careful following of the methods described should produce satisfactory results. If peculiar conditions exist, it is well to secure advice from an experienced blaster or an explosives manufacturer.

Effect of Sewage on Quality of Water at Bathing Beaches.—Results of an investigation conducted by the New Jersey State Department of Health of New Jersey to determine the effect of the discharge of sewage into the ocean on the quality of water at bathing beaches, indicate that the effluent travels approximately parallel to the shore, that the ocean water rapidly dilutes or oxidizes it, and that the surface film of effluent ultimately reaches the surf only after such great dilution that it is of higher bacterial standard than surf water where there are numerous bathers.

Results of Fine Screening and Sludge Dewatering Experiments at Milwaukee

The recently issued 7th annual report for the year 1920 of the Sewerage Commission of Milwaukee, Wis., contains much interesting information on the experiments in that city with the activated sludge process. The matter following is taken from the report.

The sewage testing station was kept in operation during the year 1920 in order to procure additional information upon fine screening and to study the problem of sludge dewatering, etc., and it has shown that the activated sludge method of sewage purification could be carried on continuously year after year without the plants deteriorating.

Fine Screening.—The Rex revolving plate screen ran through the year equipped with slotted bronze plates. The slots were 2 in. long by 3/32 in. wide. 26.2 sq. ft. of plate area were submerged in the sewage and the combined open space of the 3/32-in. slots equaled 23 per cent of the wet area.

From Jan. 1 to Aug. 9 the screen traveled at a rate of 10 lin. ft. per minute; on and after Aug. 10 it ran at the rate of 20 ft. per minute.

By increasing the rate of travel, the volume of liquor passed by the screen was increased about 12 per cent and the loss of head decreased about 30 per cent. The latter exercised the greatest influence during the middle of the day when the volume of dirt in the sewage was especially great.

The figures indicate that screens of this type can be made to produce a greater yield by "speeding" them up when the load is heaviest. This procedure provides a factor of safety that would be of value should a rush of storm water throw an unusual load upon the screen or in case a unit breaks down leaving an extra burden for the remaining screens to carry.

It is worth while to note that this Rex screen ran, with the exception of a few shutdowns amounting in all to about three weeks—from October, 1918, to January, 1921. During this time the screen passed an average of more than 5,000,000 gal. of sewage per day. Attention is called to the fact that this flow included a rate of approximately 5,500,000 gal. from midnight at 8 a. m., but only 3,000,000 gal. between 9 a. m. and 6 p. m. This low flow was caused by the accumulation of a heavy mat of screening on the surfaces of the plates, deposited by the raw sewage when it carried its heaviest charge of suspended solids.

The screenings removed amounted, on the average, to about 10 parts per million of the total solids in the sewage. This quantity was equal to about 5 per cent of the solids suspended in the sewage.

Demonstration Plant.—The demonstration plant ran continuously through the year except for a few short periods of an hour or two when the power was off, and from Oct. 19 to 28.

When the tanks were drained in October, the surfaces of the filtros plates were rinsed off by a hose and examined for cracks, softening or other signs of wear. The plates were found to be in excellent condition. They had been in practically continuous service from November, 1918, to January, 1921, a period of more than two years.

During this period, the pressure required to force the air through the plates increased about ¼ lb when passing 1.7 cu. ft. of air per square of filtros area per minute against a head of 15 ft. of supernatant sewage.

Before entering the plates, the air was cleansed thoroughly by running it through a double thickness of heavy cotton sheeting and washing this screened air in a Nash hydro turbo blower.

The air was carried in galvanized iron pipes to prevent rust from gathering on the under sides of the filtros plates. Similar filtros plates in the 1919 aeration tanks, receiving air from the same source and for the same period of time, but at a lower rate, were taken out in January, 1921, and found to be free from all foreign matter except a slight discoloration of iron rust in a few cases on the under sides of the plates.

Sewage screened through the Rex screen was applied to the aeration tanks continuously, but at a rate comparable with the expected daily flow rates. For example, between the hours of 11 p. m. and 11 a. m. sewage was run through the plant at a rate equal to the minimum dry weather flow in the city sewers; from 11 a. m. to 5 p. m. the flow was increased to the maximum daily flow, and from 5 p. m. to 11 a. m. it was run through at a rate equal to the expected flow during this period of the day.

From Jan. 1 to June 7 the aeration tanks received sewage at an average rate of 15,000,000 gal. per acre of wet surface area per day; from June 8 to Nov. 17 the rate was increased to 20,000,000 gal. per acre; and from Nov. 18 to Dec. 31 the rate was reduced to 16,000,000 gal. From Jan. 1 to March 14 air was applied at an average rate of 1½ cu. ft. per gallon of sewage; from March 15 to May 2 the rate was increased to 2 cu. ft. per gallon; from May 3 to Nov. 17 the rate was decreased again to 1½ cu. ft., and from Nov. 18 to Dec. 31 it was increased to 2 cu. ft. The records have shown that 1½ cu. ft. of air per gallon of sewage are sufficient to produce a clear and stable effluent and to maintain a bacterial removal of 95 per cent. But in passing through the Dorr thickener sedimentation tanks in cold weather the activated sludge becomes stale. For that reason it will not give its water up readily in the presses or other devices used for dewatering the sludge.

Such sludge, if thinned to 99½ per cent moisture, and then reaerated 24 hours, can be reactivated. As it is planned to adopt some such procedure to get the waste sludge into proper condition for pressing in the future, the air feed was increased, as noted above, while carrying out sludge dewatering tests in April and December.

Waste Sludge.—Over 80,400,000 gal. of sewage were passed through the aeration tanks in 1920 and produced 1,236,000 gal. of waste sludge containing 98.2 per cent of moisture on the average. The volume of waste sludge was therefore equal to 15,000 gal. of liquor, containing 98.2 per cent of moisture per 1,000,000 gal. of sewage treated.

Many experiments have been carried on to determine what method could be applied to dewater the sludge to best advantage. The tests may be divided into two groups under the headings of pressing and centrifuging.

Dewatering Waste Sludge by Pressing.—The outstanding features of the pressing operations were:

1. That in the warm weather of July and August any type of standard plate or plate and frame press may give good results.
2. That the Worthington or Berrigan press gave excellent results in the summer, and better results than the plate presses in winter.
3. That in cold weather, the sludge obtained from the Dorr thickener settling basins is so stale that it becomes much more difficult to handle.
4. That sludge taken directly from the aeration tanks in winter and dewatered in plain settling basins to 98 per cent can be pressed more readily than sludge drawn from the Door thickener. The reason for this is that the bacteria in the areation tanks do not digest the organic matter thoroughly when the temperature of the sewage is below 55° F. Such undigested sludge turns septic in the Dorr thickners and becomes colloidal in structure.

Hoping to overcome this unfavorable condition many tests were made by adding commercial sulphuric acid to the sludge before pressing. The principle of the acid treatment depends upon a modern theory of colloidal chemistry which holds that colloidal bodies bound together by a combination of positive and negative charges of electricty, can be split apart by adding an excess of negative acid electrons.

When enough sulphuric acid was added to the waste sludge to make the liquid slightly acid, the sludge generally pressed more rapidly than when acid was not added. The volume of acid required varied, but in general sludge containing from 50 to 100 parts per million of acid to methyl orange indicator gave the best results. It also was found that the sludge has a tendency to change back, gradually, from acid to alkaline. Upon making accurate laboratory tests, it was proven that the methyl orange neutral point produces in our sludge a pH value of about 4, and that sludge acid to methyl orange to the extent of 100 parts per million has a pH value in the neighborhood of 2.8.

In order to illustrate the relative advantage of pressing aeration tank sludge dewatered in plain settling basins with sludge dewatered in Dorr thickeners, data obtained in February, 1920, are given in the following table:

Source of Sample	Date, 1920 Feb	% moisture in sludge to press	% moisture in press cake	Lbs. of press cake	Time required in hours	Acid reaction to Methyl orange (p.p.m.).
Fresh	2	98.1	[illegible]	212	6.6	60
Aeration tank sludge	3	97.9	79.6	223	6.5	15
Stale sludge from Dorr thickeners	5	97.4	80.5	188	6.5	40

In order to illustrate the relative efficiency obtained by pressing winter sludge as compared with summer sludge, data obtained in February and in August, 1920, are given in the following table:

SLUDGE FROM DORR THICKENER

Date, 1920	% moisture in sludge to press	% moisture in press cake.	Lbs. of press cake	Time required in hours	Acid to Methyl orange (p.p.m.).	Remarks
Feb. 5..	97.4	80.5	188	6.5	40	Cake wet and bags too dirty for another press.
Aug. 25.	97.8	78.0	234	4.2	25	Very fine cake. Bags are clean enough for more pressing.

Records obtained with a Worthington press in cold versus warm weather:

SLUDGE FROM DORR THICKENER

Date. 1920 –	% moisture in sludge to press.	% moisture in press cake	Lbs of press cake	Time required in hours	Acid to Methyl orange (p.p.m.).	Remarks
April 21.	98.3	77.9	1,760	6.5	30	Cake fairly dry
Aug. 13.	97.1	80.3	2,267	3.6	20	Very fine cake and bags are clean.

The records in the preceding table show that the sludge dewatered in the Dorr thickeners in summer can be pressed readily in any one of the usual types of presses, but that during the winter season a much longer time is needed.

Dewatering Waste Sludge by a Centrifuge.—Many experiments were carried on during the fall with a 36-in. solid bowl centrifuge of Dr. ter Meer's design. One of the features of this machine which made it appear to be better adapted to dewatering sludge than the type used in the experiments in 1919 lies in the fact that it dumps its cake automatically.

A timing device attached to the driving shafts can be regulated by a simple means of adjustment to open and close the inlet valve, discharge the cake, etc., in periods ranging from two minutes to one hour or more. The machine does not contain any filtering mediums such as sieves, cloths or other dewatering devices common to many centrifuges now on the market. The sludge can be fed into the machine at any desired rate, but the effluent from the machine carries over some of the solids suspended in the raw sludge and therefore the effluent is turbid.

When treating the activated sludge, consisting of 98 per cent water and 2 per cent solids, the machine has been made to remove from 10 to 90 per cent of the suspended matter. The amount taken out varies with the composition of the sludge, rate of inletting in gallons per minute, length of time of inletting, and speed at which the drum revolves.

The cake will vary in composition according to the factors noted above, and it may also be changed in character by using a "skimming tube," which can be set to take off from 2 to 4 in. of the portion of cake nearest to the center of the drum. The moisture of the cake can be reduced by post centrifuging, or running the machine after the sludge feed has been shut off, as well as by "skimming off" the top layer described above. The cake, when deposited, was usually about 5 in. thick.

On Oct. 10, 1,600 gal. of sludge containing 98.2 per cent moisture were run into the machine at a rate of 26½ gal. per minute. As a result, the cake produced contained only 69.6 per cent of moisture. On Oct. 4, 282 gal. of sludge containing 97.8 per cent moisture were run into the machine in 10 minutes and a cake obtained which carried 84.3 per cent moisture. These two runs are typical of what the machine will do when operating upon long and short periods of centrifuging.

A typical section of the Oct. 4 cake was divided into four parts. The bottom quarter, which was opposite the point where the sludge entered, contained 79.04 per cent of moisture; the next section, 84.81; the third, 86.45, and the top section, 87.54 per cent moisture. Evidently, therefore, the inside and top layers contain more moisture than the outside section. This condition is due to the fact that the densest particles with greater specific gravity [illegible] most readily in the action of centrifugal force and fly to the outer edge. Not only does the centrifuge tend to separate the [illegible] and [illegible] from the colloidal and [illegible] particles, but it seems also to classify the nitrogen. [illegible] hair, which carry much total nitrogen and only a small quantity of available nitrogen, fly to the wall, whereas the colloidal material that is rich in available nitrogen locates in the wet [illegible] coating or passes out with the effluent.

Removal of Tastes from Gas Plant Liquors by Activated Sludge.—Milwaukee has been afflicted from time to time by obnoxious tastes resembling carbolic acid in the drinking water.

As activated sludge has a great power of absorption for such materials a series of tests were carried out at the Milwaukee sewage testing station by adding measured volumes of "ammonia condensation liquor" to the sewage entering one of our aeration tanks. The condensate was found to contain 1.44 grams of phenol (carbolic acid) per 1,000 c.c. of liquor. This, when mixed with condensed steam, etc., as delivered to us, carried 0.78 grams per 1,000 c.c. The "A. C." liquor contained some cresol, sulpho-cyanide, sulphur phenol and other taste producing compounds.

Liquid chlorine, such as is used to sterilize the city water, accentuates the tastes produced by some of these bodies. Therefore the raw A. C. liquor was diluted and chlorinated to see how strong it was in taste producing power. The tests proved that one part of the liquor could be detected easily in 40,000 parts of chlorinated lake water. This "A. C." liquor was added to the sewage entering an aeration tank in a continuous stream from Aug. 31 to Sept. 10. The quantity ranged between 0.8 per cent and 9.1 per cent of the sewage flow.

No taste of consequence was discovered in the effluent from the final settling basins except upon one or two occasions. At such times the taste was so slight that, when the effluent was diluted with an equal volume of lake water, no taste could be noted in the diluted sample.

According to the figures now available, the volume of "A. C." liquor will not exceed 1 per cent of the sewage flow even if the present coke and gas works are enlarged to double capacity. For that reason the sewage disposal plant should protect the water supply from tastes produced from ammonia condensation liquors cast into the sewers in the future.

Portland Cement Output in December

The production of finished portland cement in the United States in December, 1921, was approximately 6,559,000 bbls., according to a press notice of the U. S. Geological Survey. As compared with the production in November, 8,921,000 bbl., this represents a decrease of 2,362,000 bbl. A seasonal decline was to be expected, and though the production in December, 1921, was less than in December, 1920, it was about 14 per cent more than the average for December from 1917 to 1921. The production in 1921, 98,293,000 bbl., was over 98 per cent of that in 1920, and was greater than that for any other year except 1920.

The shipments in December, following the usual trend, showed a decrease from those in November. The movement in December, 3,697,000 bbl., was over 9 per cent greater than that in December, 1920, but was slightly below the average for December during the last five years. The shipments made during the last half of 1921, 54,976,000 bbl., were approximately the same as those made during the last half of 1920. The total shipments in 1921, about 95,051,000 bbl., were nearly 99 per cent of those in 1920.

Stocks of about 11,938,000 bbl. of finished cement were in the hands of the manufacturers at the end of 1921, as compared with [illegible] bbl. at the end of 1920. This total exceeded the average stocks in hand at the end of the year from 1917 to 1921 by over 27 per cent. From April until October stocks of finished cement decreased steadily, but in November and December they increased. Stocks are usually accumulated during the colder months in anticipation of the large requirements in the months of active demand.

Motor Car Production in 1921.—A total of 1,680,000 automobiles and motor trucks were made in 1921, a decrease from 1920 production of 21 per cent. Of this total 1,525,000 were cars.

Effect of Gas Plant Wastes on Taste and Odor of Water

The discharge of liquid wastes from by-product coke ovens and commercial gas plants into streams and lakes from which water supplies are taken, has become, during the past few years, a matter of grave concern to many medium sized and several of the largest cities, due to the disagreeable tastes and odors which these wastes impart to the water.

Some interesting points on the matter were brought out by Mr. C. A. Emerson, Jr., Chief Engineer Pennsylvania State Department of Health, in the recent symposium of the American Society of Civil Engineers on Water Supply and Water Purification. In the subsequent discussion Mr. C. M. Baker, State Sanitary Engineer of the Wisconsin State Board of Health, gives some particulars regarding experiences in his state. We are reprinting the matter following from the December and January Proceedings of the Society.

Interference with Water Filtration Plant Operation by Wastes from By-Product Coke Ovens and Gas-Works

By C. A. EMERSON, JR.

As the superiority of by-product coke ovens over the old beehive type is now fully established, it follows that the number and capacity of these installations will undoubtedly increase. By-product ovens of necessity must be located reasonably close to a steel works or a large municipality in order to secure a ready market for the gas given off during the coking of the coal, and, therefore, it is almost certain that interference with surface water supplies will also increase, if proper precautions are not taken.

The wastes from the tar separators, the ammonia, benzol, and naphthalene stills of by-product coke ovens, together with the sludge removed from the various gas an oil mains throughout the plant, impart a characteristic taste to river water. This taste may persist for days and, after transportation for many miles, be noticeable in the effluent from well operated, water filtration plants of modern types, taking their raw water supply from the stream. The application of chlorine, even in the minute quantities used for water supply treatment, seems to accentuate rather than diminish these taste-producing characteristics. Under favorable conditions, dilutions as great as several million parts of chlorinated water to one of the wastes have failed to cause complete disappearance of this taste.

Remedy for the Pollution Lies Within the Works.—Fortunately the remedy for this pollution lies within the works, and consists simply of evaporation of the contaminated liquid wastes by using them for quenching or cooling the glowing coke taken from the ovens. The waste water which is not turned into a cloud of steam, but passes through the quenching platform, is intercepted in settling basins and again used for quenching. In all the plants coming under the speaker's observation, the water requirements for coke quenching have exceeded the volume of contaminated wastes, so that this remedy has not worked a hardship on the owners.

That the remedy is effective is evidenced by the fact that the largest by-product coke oven installation in the world is operating on the Monongahela River, 10 miles above the intake of a municipal waterworks, without causing contamination of the supply. Take another stream in Pennsylvania as an example: The installation of appliances for using liquid wastes from stills for quenching the coke silenced complaints among the consumers of filtered water in several municipalities along the stream about 70 miles below the works. That the method is beyond the experimental stage is indicated by the fact that it has been in successful use at numerous plants for several years and that, in some instances, the volume of liquid wastes evaporated is in excess of 1,000,000 gal. daily.

Interference with water supplies by the wastes from plants producing water gas for illuminating and power purposes has been noticeable in different parts of the United States. Definite evidence that the tastes due to these wastes are as persistent or that they can be detected in as high dilutions, as those from by-product coke ovens, seems to be lacking. There is, however, sufficient evidence to justify the statement that the raw wastes from these plants, when subjected to dilutions available in rivers of considerable size, will cause tastes after transportation by the stream for several miles. With these wastes, also, the taste-producing characteristics are accentuated by chlorination of the drinking water taken from the stream.

Aeration of Considerable Value. Aeration of the raw water, thus contaminated, prior to filtration seems to be of considerable value, but in this case, again, a certain and effective remedy can be developed at the gas works. It has been found that installation of settling and skimming basins to permit the removal of the greater portions of the heavier tars and the light floating oils, with the circulation of the basin effluent for re-use in the "gas scrubbers," will not only materially decrease the proportion of active taste producing constituents, but will reduce the volume of wastes reaching the stream to a small fraction of that which occurred before the water was re-circulated through the plant. In addition, the company recovers marketable materials to offset the cost of operating the circulating pumps.

In one instance coming to the speaker's attention recently, it was deemed advisable to require the gas company to go even further, and to keep all liquid wastes from the stream. This company, by the use of settling basins and circulating pumps, had decreased the volume of wastes from 50,000 to about 5,000 gal. per day. This waste was high in turbidity, had an oily appearance, and was brown in color, but it was found that after straining it through a layer of coke breeze, about 6 or 8 in. in thickness, and receiving a moderate application of ferrous sulphate solution, it could be passed through a small sand filter at a rate of about 400,000 gal. per acre daily and then become a satisfactory boiler water. Contrary to all expectations, the sand filters did not clog immediately, but were operated for runs of several days' duration between scrapings.

Occasionally, there has been doubt as to legal authority to require abatement of the class of pollutions described, as the laws controlling stream pollution due to the discharge of industrial wastes are weak and vague in many states; however, instances are recorded where applications for restraining injunctions have been granted under the broad general rights of lower riparian ownership and, accordingly, it is believed that in a surprisingly large number of cases definite obligations can be imposed on owners of such works to prevent troublesome stream pollution.

Experiences at Milwaukee

By C. M. BAKER.

In the fall of 1918, before the speaker took up the work with the State Board of Health, exceedingly objectionable tastes and odors prevailed in the water supplied to the citizens of Milwaukee. In fact, it has been authentically stated that these conditions were so severe as to make the use of foods cooked in the water objectionable. The taste was ordinarily described as a medical taste, and did not resemble the taste of waters treated with an excess of chlorine. Furthermore, the tastes and odors occurred at infrequent intervals, not continuously, and the quantity of chlorine applied appeared to have little, if any, effect on the production of the objectionable conditions.

An extensive investigation was conducted, largely by the chemists of the Water Department and the City Health Department, which consisted in the collection of samples of water from the rivers and harbors in Milwaukee, and also of different industrial wastes. These samples were treated with an excess of chlorine, which later was driven off by boiling, and the test was made by tasting or smelling the samples thus treated. It was determined in this way that the taste-producing properties were confined exclusively to those wastes from industries producing coal-tar derivatives; other wastes seemed to have no effect. It was further determined that phenol was the most objectionable substance in producing these conditions. The investigators claimed that by their method of testing, previously mentioned, the presence of phenol in a solution, as great as 1 part in 500,000,000, could be detected. At that time (1918), the State Board of Health and the Governor of Wisconsin were consulted. Numerous hearings were held, and finally by testing samples collected from Lake Michigan, the source of the trouble was traced directly to a Government phenol plant at Carrollville, about 15 miles from the Milwaukee intake. The matter was taken up with the Government and, in the fall of 1918, this plant was closed.

It was thought that the closing of the Carrollville plant had eliminated the objectionable conditions, but a slight recurrence of the odor was noticed in December, 1919, and in March or April, 1920. This latter condition was more severe than that of December, and the State Board of Health was again called in consultation. At that time, the plant at Carrollville was operating on an entirely different basis, and was discharging no phenol wastes into the lake. It was apparent, therefore, that the source of the pollution was elsewhere. The previous investigation, however, had failed to show the taste-producing quality in any of the samples collected in the harbor or the rivers. It was apparent, therefore, that the evidence was not conclusive against the two or three plants in Milwaukee known to produce wastes which were apt to cause the objectionable conditions. A rather complete investigation, therefore, was outlined and undertaken. Thousands of samples were collected from the rivers and harbor, and tested.

Three rivers enter the harbor at Milwaukee, namely, the Milwaukee from the north, the Menomonie from the east, and the Kinnickinnic from the south. The Milwaukee Coke & Gas Co. discharges its wastes into a slip tributary to the Kinnickinnic River and the Milwaukee Gas Light Co. directly into the Menomonie River. The Milwaukee River and the Kinnickinnic River are flushed by tunnels from the lakes; the Menomonie River, however, is not flushed.

In the testing of samples, it was soon learned that there was only occasional taste-producing qualities in the samples collected from the harbor outlet. By continuing the tests up the stream, the Milwaukee River was eliminated as a factor, but rather intense concentration was found in the Menomonie River—coming from the east—particularly just below the Milwaukee Gas Light Plant. On one or two occasions the taste-producing quality was observed in the water at the mouth of the Kinnickinnic River, and, on a few occasions, in the harbor outlet. A careful study of the relation of wind conditions with reference to the taste in the water supply indicated quite conclusively that the conditions necessary to cause tastes were a west wind, followed almost immediately by a southwest wind. Certain intensity and duration of the wind was also necessary. Furthermore, it was learned that samples collected from the harbor outlet showed taste on test only during westerly winds. It was concluded, therefore, that the conditions causing taste and odor in the Milwaukee water supply were: First, the accumulation of wastes from the Milwaukee Gas Light Co. in the Menomonie River and from the Milwaukee Coke and Gas Co. in the slip tributary to the Kinnickinnic River; and, second, by west winds carrying the accumulated pollution out of the harbor, followed by southwestern winds carrying the pollution to the water intake.

The solution suggested was to provide for the continuous discharge of the wastes, thus prohibiting the intermittent discharges caused by changing winds. The wastes from the Milwaukee Gas Light Plant, therefore, were pumped into a sewer discharging directly into the Milwaukee River, which sewer is flushed daily. The slip which receives the waste from the Milwaukee Coke and Gas Co. was dammed and a pipe carried back of the dam for a distance of about 40 ft., to provide for the gradual discharge of the waste from this slip. These changes were made about a year ago, and there has been no recurrence of the objectionable conditions.

Sixty-five Illinois Cities Have Commission Government.—Up to Feb. 1, 65 cities in Illinois had adopted the commission form of government. Springfield adopted the commission system on Jon. 2, 1911. Moline and Rock Island followed the next day, and 16 other cities took similar action during the year. Every year since, except 1918, has seen new municipalities added to the list. Under the commission government law of Illinois the administration is placed in the hands of a council composed of a mayor and four commissioners, each having a department of the city government under his control, the mayor holding the helm. The chief executive however, holds no veto power and as presiding officer of the council has but one vote.

Water Power Developments.—In the 16 months following passage of the Federal Water Power act there were filed with the Federal Power Commission 185 applications for preliminary permits and 85 applications for license to develop water power.

Proper Charges for Fire Protection

By HENRY L. GRAY

Consulting Engineer, Seattle, Wash.

[This study and analysis of water rate charges and earnings was prepared by Mr. Gray in 1921 as a report to the Pacific Power & Light Co. on its water plant and business in the city of Yakima, Wash. A large part of the report is devoted to the apportionment of property used jointly in rendering ordinary commercial service and in fire protection. At its conclusion there is given a very valuable table showing proportions of plant values and gross revenues in other cases, together with a page reference to the official report on each. We give Mr. Gray's report in full with the exception of some diagrams of statistics from reports of the Wisconsin Railroad Commission.—Editor, Engineering & Contracting.]

With its present population and area, the city of Yakima should pay annually to the Pacific Power & Light Co. for its services in providing fire protection for the city, the sum of $27,882.

Determination and Discussion. The amount which the city of Yakima should pay annually to the Pacific Power & Light Co. for fire protection service, of $27,882, was arrived at by the use of the Maximum Demand Method of plant apportionment, this method having been extensively used by the Railroad Commission of Wisconsin, and by other commissions. It has the sanction of all leading writers upon the subject.

At the present time the number of fire hydrants installed in the city of Yakima is 165. These hydrants have been installed at the expense of the city, and are owned by the city. As a service charge for fire protection, the city pays the company at the rate of $3.75 per month, or $45 per year, for each hydrant, or a total annual gross payment for fire protection service of $7,425. It is proposed to increase this gross revenue from fire protection service to $2,500 per month, or $30,000 per year, without any limitations upon the number of hydrants which the city may install in connection with the existing system of mains. In view of the substantial increase to the city in the cost of fire protection, it is necessary to present to the Department of Public Works certain facts and figures in substantiation of the proposed increase.

The Apportionment Problem. It is accepted as fundamental that every water system, whether privately or publicly owned, is entitled to receive sufficient revenue to compensate it for all reasonable expenses incurred in furnishing its service, including the cost of operation and maintenance, taxes, replacement charges, and a reasonable return upon the fair value of its property. Having determined the fair compensation which the water system should receive from its service as a whole, the question then arises as to what portion of the total revenue should be provided by the different divisions of service, which may be stated to be as follows: (1) to supply water for private uses; (2) to supply water for public use on streets, and for sewers, fountains, public buildings, etc.; (3) to furnish fire protection to property.

Customs and Authorities.—The cost of public fire protection must necessarily be borne by the property directly receiving the benefit of that service. This fact is accepted by all leading writers on the subject, and by all commissions having to do with the regulation of rates. The point at which expert opinion diverges is the method of arriving at the proper charge for fire protection. Ordinarily water is paid for upon the basis of the amount used, but it is well recognized that the amount of water actually consumed in extinguishing fires will reflect only a small percentage of the total expense incidental to fire protection service. The standard scientific work on public water supply by Turneaure and Russell in commenting upon the three classes of service previously outlined, states:

> "In (1) and (2) the cost of service may be considered approximately proportional to the quantity of water supplied, but in (3), or fire protection, it is not at all proportional to the amount of water used, for while the cost of construction is greatly affected, the total amount of water consumed is small. The extra cost is, therefore, due principally to the need of increased pumping capacity, increased size of mains, reservoirs or stand pipes and of hydrants, and increased cost of maintenance."

The common system of charging for fire protection upon a hydrant rental basis was long ago recognized as being unjust. The most comprehensive paper ever published dealing with the question of proper charges for fire protection service was that entitled, "Some Fundamental Studies in the Determination of a Reasonable Return for Public Fire Hydrant Service," prepared by Messrs. Metcalf, Kuichling and Hawley, reported in the 1911 Proceedings of the American Water Works Association, on page 55. In this article, it is stated:

> "The usual method of paying for public fire protection service is by an annual rental per hydrant. * * * * It is believed that this method of charge is a less equitable one than would be a payment of a lump sum for public hydrant service, granting to the city the right to attach as many hydrants as it may desire to the water mains of the company."

Number of Hydrants No Criterion. The system of charging for fire protection upon the basis of a certain sum per hydrant, which sum generally approximates the corresponding rental charged in other cities, without any regard whatever to the proper charge to be made for fire protection service, is an ancient system, but it is difficult to see why it still exists, in view of the fact that regulatory bodies all over the country have condemned it. As the Wisconsin Commission stated in the Oconto case:

> "The cost of furnishing fire protection bears little relation to the number of hydrants. The demand upon the plant is practically independent of the number of hydrants, but is determined by the fire risks, which demand is expressed in terms of fire streams of a certain diameter and pressure."

In other words, the cost of furnishing fire protection is not measured by the pro rata cost of furnishing a certain quantity of water, but instead consists principally of investment charges due to providing a plant of sufficient capacity to care for the demands of a city during conflagrations. Therefore the cost of fire protection is very largely made up of fixed charges, or interest, taxes, and replacement charges. So it follows that the first important step in arriving at a proper charge for fire protection in the case of any plant is to determine what part of such plant should be considered as being required on account of the necessity of adequate provision for the extinguishment of fires.

At this point it may be well to state that anyone disagreeing with this conclusion will receive little comfort from the decisions of Commissions and Courts, for an analysis of every decision on this question which has been rendered by regulatory bodies shows that those experts have very promptly considered the necessity of primarily apportioning a certain part of the plant to fire protection service. The only differences of opinion have been as to the method of making this apportionment.

Methods of Apportionment. In general three methods have been followed in apportioning water systems between fire protection service and other service. These methods may be referred to:

(1) The Residue Plant Method.
(2) The Comparative Plant Method.
(3) The Maximum Demand Method.

The first method referred to is based upon the assumption that a water system is designed primarily for domestic and industrial purposes, and that owing to the necessity of providing fire protection, certain additional facilities in the way of increased size of mains, etc., must be provided. The first step therefore consists in arriving at an approximate reproduction cost of the plant as a whole. The next step consists in arriving at the reproduction cost of a plant sufficient only to provide for service other than fire protection. The difference between the two reproduction costs is presumed to reflect in dollars that part of the plant required solely for fire protection purposes. It requires only a moment's thought to demonstrate the extreme fallacy of this theory. In the first place, a very substantial portion of the cost of that part of a water system used for fire protection purposes bears little or no relation to excess facilities provided for fire protection, such as larger sizes of mains. This is particularly true in the case of the mains themselves, where a substantial part of the cost is due to trenching and back filling. There is very little more cost to trenching and back filling in the case of a 10 in. main than in the case of a 6 in. main. Now it might logically be assumed that a water system is primarily constructed for fire protection service, in which case a very substantial part of the cost of trenching and back filling would be shifted to fire protection; so that by a slight change in assumptions, the percentage of plant to be assigned to fire protection service would be materially changed; and no theory which will provide two different answers from the same set of figures, can be regarded as anything more than a novelty. However, this method has been used to a limited extent by regulatory bodies, and is advocated by Mr Joseph Goodman in his article entitled, "Determination of the Value of Fire Protection Offered by the Queens County Water Company" (Proc. Am. W. W. Assn. 1916).

The second, or Comparative Plant Method, is much more logical, in that it requires the determination of the reproduction cost of a system to provide for all service other than fire protection, as well as the reproduction cost of a system for fire protection only. In this manner it is possible to determine a relation between that part of the plant required for fire protection service and for other service. This method is advocated by Mr. John W. Alvord in his article, "Equitable Hydrant Rentals and Better Methods of Apportioning Fire Protection Cost." (Proc. Am. W. W. Assn. 1914.) It was also used by the Wisconsin Commission in its pioneer case of City of Ashland v. Ashland Water Company (WRCR. 4, P. 273), and has been followed to a considerable extent in all later cases of the same kind decided by the Wisconsin Commission. The trouble with this theory is that if carried to its logical end it requires a vast amount of work, and approaches the realm of conjecture. And inasmuch as the relative reproduction cost of each of the hypothetical systems will depend to a considerable degree upon the demand which is to be imposed upon each system, this method in fact is nothing more nor less than the third, or Maximum Demand Method. This is made quite clear by the Wisconsin Commission in the Ashland case.

The third method, or the Maximum Demand Method, is really the method which has been generally used by the Wisconsin Commission. It involves the determination of the relation between the maximum demand liable to be imposed upon the system by the fire department, and that imposed upon the system by service other than fire protection. A comparison of these two demands indicated what part of the system should be assigned to fire protection service. It is a method advocated by Mr. Kuichling, and in one of its leading cases, or that of the City of Janesville v. Janesville Water Company (WRCR. 7, P. 628), the Wisconsin Commission discusses it as follows:

> "Assuming that the maximum demands of the two classes of service will coincide, the fire demand has been found to constitute 44 per cent, and the general demand 56 per cent of the total. In practice, it is not at all probable that the maximum demand of one service will be exerted at the same time as the greatest demand for the other. * * * An apportionment on the basis of the separate maximum demands, therefore may result in somewhat less than its fare share or capacity expenses being charged to the fire service. * * * Although the apportionments based on the separate maximum demands may result in understating the amount properly to be charged to fire protection, this basis of apportionment appears to bring nearer the correct result than any other basis available."

Other Commissions have given careful consideration to this method, particularly the Indiana Commission in the case of Apple v. City of Brazil, in which case the Commission adopted the maximum demand method, and then used it improperly. However, it should not be inferred that all decisions rendered by Commissions touching upon this subject have sanctioned the maximum demand method. A number of them have been a trifle vague in regard to the method used, whereas in a few instances other two methods have been adopted. But in the great majority of cases where regulatory bodies have clearly expressed themselves, it will be found that in substance, the maximum demand method of plant apportionment has been followed. The exact workings of this method will be made clear by the following application of it to the case at hand.

Studies, Data and Calculations for Yakima.—The estimated cost of construction of the Yakima water system, to December 31, 1920, as shown by the report of the engineer of the Department, was $931,195, including stores and working capital. For the moment assume this to represent the minimum fair rate base, and assume the minimum fair return to cover money cost, taxes and depreciation, to be 13 per cent. Then the total revenue required from the operation of the system, to cover money costs, taxes and depreciation, will be 13 per cent of $931,195, or $121,055. How much of this should be obtained from fire protection service?

Of the total estimated construction cost shown above, or $931,195, the following items represent property used actively in rendering fire protection service and other service, the cost of which property was directly affected by reason of its use in rendering fire protection service:

Water rights .	[illegible]
Substitute supply line	[illegible]
Transmission mains	111,800
Reservoir	[illegible]
Booster pump set	[illegible]
Distribution mains with [illegible] 4" and over	[illegible]
	$615,047

Maximum Demands. This property may be apportioned between fire protection service and other service upon the basis of maximum minute demands, as follows:

The average consumption of water in Yakima per minute of time during the calendar years 1918, 1919 and 1920, was approximately 850 gallons. It is a recognized principle that the maximum minute demand for all purposes other than fire purposes will be from 2 to 3 times the average minute demand for a yearly period. Using the factor of 3, it is found that the probable minute demand in Yakima for purposes other than extinguishing fires will be approximately 2,550 G. P. M.; but on account of unmetered uses, it is advisable to increase this to 2,650 G. P. M.

According to the formulae commonly used, which take population into consideration, the number of 250 G. P. M. fire streams which might be required in Yakima at any one time are 12, delivering a total of 3,000 G. P. M. However, it is probable that such delivery is considerably in excess of the needs of Yakima. According to the Fire Department, a very serious fire could be handled with 1,500 G. P. M., which would be available, as the old pump, operating at 120 lb. can deliver 3 streams, or 650 G. P. M., while the new pump can handle 4 streams at 120 lb., delivering 1,000 G. P. M. Therefore, let it be considered that the demand of the fire protection service will be equal to the capacity of the fire fighting equipment, or 1,650 G. P. M. The sum of the two demands will be 4,300 G. P. M., of which the fire demand of 1,650 G. P. M. will be approximately 38 per cent. Therefore upon the demand basis, 38 per cent of the jointly used property shown as having a construction cost of $615,047, or $233,718, should be assigned to fire protection service. The fixed charges upon the same, or 13 per cent, would be $30,383, having $90,672 of fixed charge to be provided from other service.

Operating Expenses.—The operating expenses for the year 1920 amounted to $43,895. Of these expenses, the following were directly affected by the fire protection service.

Pump station labor	$ 9.00
Lubricants	18.50
Miscellaneous supplies and expenses	.72
Electric power	1,635.53
Maintenance, source of supply	2,296.68
Maintenance, pump equipment	3.45
Total transmission expense	365.93
Dist. op. superintendence .	319.41
Dist. op. mains and hydrants	128.74
Dist. op. misc. supplies and expenses ...	628.56
Maintenance mains, valves and misc.	4,576.44
	$10,282.96

Unquestionably much of the remaining $33,612 of expense could be considered as being due in part to fire protection service. But in order to be absolutely safe, only the expenses enumerated above will be used. It is rather difficult to apportion these expenses, but inasmuch as such a large part of their total relates to the maintenance of property of which 38 per cent was assigned to fire protection, it seems fair to assign at least one third of this expense, or approximately $3,500, to the fire protection service.

Earnings Required. Hence the minimum gross revenue required from fire protection service and from other service will be as follows:

	Interest taxes and replacement.	Cost of operation	Necessary gross
Fire protection service	$ 30,383	$ 3,500	$ 33,883
All other service	90,672	40,395	131,067
	$121,055	$ 43,895	$164,950

A comparison with the necessary gross with the actual gross obtained in 1920 is as follows:

	Actual gross.	Required gross.	Deficit
Fire protection service	$ 7,399	$ 33,883	$ 26,484
All other service	85,130	131,067	45,937
	$ 92,529	$164,950	$ 72,421

Comparison With Other Cases.—At this point it may be proper to compare the results obtained by this calculation with those obtained by other engineers, and by regulatory bodies using the maximum demand method of apportionment as well as other methods. In order to make this comparison intelligently and quickly, it is necessary to remember two things: [illegible] that in the case at hand the percentage of total plant value assigned to the fire protection service was 25.1 per cent; [illegible] that in the case at hand, the percentage of the gross required from fire protection service was 20.6 per cent of the total gross. Knowing these two things, the comparison is easily made.

In the comprehensive paper prepared by Messrs. Metcalf, Kuichling and Hawley, reported in the 1911 Proceedings of the American Water Works Association, it is stated:

"It is believed that a fair statement of the present conditions would be to say that the cost of the portion of a water works plant reserved for fire protection service probably constitutes from [illegible] per cent to [illegible] per cent of the entire cost of the [illegible] property in the case of communities having less than [illegible] population; 20 per cent to [illegible] per cent in the case of communities of [illegible] population, more or less, and perhaps [illegible] per cent to [illegible] per cent in the case of our largest cities."

Following this statement, certain formulae were derived, and tables were compiled showing the proper percentage of the cost of water systems assignable to fire protection purposes as compared with certain percentages obtained by the use of the maximum fire protection requirements of the National Board of Fire Underwriters, as follows:

Population	[illegible] per cent	N. B. F. U. per cent
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

This article was the pioneer work upon the question of proper charges for fire protection, and while it was based largely upon conditions in connection with eastern plants supplied by pumping, yet at the same time, its fundamentals cannot be ignored.

These questions have been passed upon in a large number of instances by the Wisconsin Commission, and by other commissions. The following tabulation shows the percentages of plant value allotted to fire protection service, and the percentage of the gross required from fire hydrant service as found by the several commissions. In most instances the percentages shown were clearly set out in the reports cited, but in other instances it was necessary to make certain calculations in order to arrive at the percentages allowed. But in every instance, the percentages shown are sufficiently correct for all practical purposes. The figures to be used in comparison with those derived for Yakima are contained in the two columns shown under head of "Per Cent to Fire Protection." The left hand column shows the percentages of total plant values assigned to fire protection service. The figures in this column are to be compared with the percentage of the construction cost of the Yakima plant assigned to fire protection service, or 25.1 per cent. The figures in the right hand column show the percentages of the gross revenues which it was considered that the fire protection service should provide, these to be compared with the corresponding figure of 20.6 per cent in the case of Yakima. It should be noted that in a number of the cases reported, the percentages of the gross shown covered sewer flushing, as well as fire protection service. From these comparisons it will be seen that the calculation made in arriving at the proper charge for fire protection in Yakima has been very conservative.

TABLE [illegible]—PERCENTAGE OF PLANT VALUE ALLOTTED AND GROSS EARNINGS REQUIRED FOR FIRE SERVICE

			Per cent to fire protection				
	State and City	Population	Plant Value	Gross	Reference		
1	Wis.—[illegible] Lake	[illegible]	[illegible]		WRCR	11,	[illegible]
2	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	WRCR	8,	[illegible]
3	Wis.—[illegible]	[illegible]	[illegible]		WRCR	15,	[illegible]
4	Wis.—[illegible]	[illegible]	[illegible]		WRCR	12,	194
5	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	WRCR	14,	[illegible]
6	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	WRCR	16,	[illegible]
7	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	WRCR	11,	197
8	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	WRCR	11,	[illegible]
9	Wis.—[illegible] Falls	[illegible]	[illegible]	[illegible]	PUR	1917E,	[illegible]
10	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	WRCR	12	118
11	Wis.—Columbus	[illegible]	[illegible]	[illegible]	WRCR	11,	119
12	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	WRCR	5,	[illegible]
13	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	WRCR	17,	216
14	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	WRCR	12,	260
15	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	WRCR	5	1
16	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	WRCR	12,	[illegible]
17	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	WRCR	7,	[illegible]
18	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	WRCR	11	118
19	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	WRCR	[illegible]	[illegible]
20	Wis.—Watertown	[illegible]	[illegible]	37.2	WRCR	[illegible]	[illegible]
21	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	WRCR	4	[illegible]
22	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	WRCR	11	1
23	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	WRCR	7	628
24	Wis.—Marinette	[illegible]	[illegible]	31.1	WRCR	8	[illegible]
25	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	WRCR	7	[illegible]
26	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	PUR	[illegible]	1005
27	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	PUR	1921A,	299
28	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	WRCR	[illegible]	[illegible]
29	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	WRCR	[illegible]	[illegible]
30	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	WRCR	11	[illegible]
31	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	PUR	[illegible]	[illegible]
32	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	WRCR	5,	[illegible]
33	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	PUR	[illegible]	[illegible]
34	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	WRCR	[illegible]	[illegible]
35	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	WRCR	[illegible]	[illegible]
36	Wis.—[illegible]	[illegible]	[illegible]	[illegible]	PUR	[illegible]	[illegible]
37	[illegible]	[illegible]	[illegible]	[illegible]	PUR	[illegible]	[illegible]
38	[illegible]	[illegible]	[illegible]	[illegible]	PUR	[illegible]	[illegible]
39	[illegible]	[illegible]	[illegible]	[illegible]	PUR	1917A,	[illegible]
40	[illegible]	[illegible]		[illegible]	PUR	[illegible]	[illegible]
41	[illegible]	[illegible]		[illegible]	PUR	[illegible]	[illegible]
42	[illegible]		[illegible]	[illegible]	PUR	[illegible]	[illegible]
43	[illegible]	[illegible]	[illegible]	[illegible]	PUR	[illegible]	[illegible]
44	[illegible]	[illegible]	[illegible]	[illegible]	PUR	[illegible]	[illegible]
45	[illegible]			[illegible]	PUR	[illegible]	[illegible]
46	[illegible]			[illegible]	PUR	[illegible]	[illegible]
47	[illegible]			[illegible]	PUR	[illegible]	[illegible]

In using the table following, it should be noted that cases shown on lines 40 to 47 inclusive relate to water districts and to boroughs, rather than to individual cities, and the statistics contained in the decisions covering these cases were extremely complicated, so that in some instances it was rather difficult to determine all of the conclusions reached by the Commission. Furthermore, in each of these cases a number of outlying districts, probably without fire protection, were included. This table is followed by certain blue print charts, which should prove of interest to the Department, and which may prove useful in future cases.

While the Public Service Commission of Washington to date has not been called upon to definitely fix the percentage of plant or operating costs to be allocated to fire protection, yet the principles outlined in this discussion have been recognized by the Washington Commission and discussed at considerable length in City of Monroe v. Monroe Water Company (PUR 1920E, 445), and Pittock and Leadbetter Lumber Company v. North Coast Power Company (PUR. 1920F. 384). In each of these cases the Commission stated that it was generally estimated that from 30 per cent to 70 per cent of the total cost of a water system should be allocated to fire protection service, the percentage varying with the population.

Abbreviations used in the table are: WRCR—"Wisconsin Railroad Commission Reports;" PUR—"Public Utility Reports."

Cities Should Know Mineral Content of Water Supply.—A knowledge of the mineral content of city water supplies is of sufficient industrial value to justify more cities to make such analyses, according to the Bureau of Chemistry, United States Department of Agriculture. The quality of the water of a locality, it is pointed out, may be the controlling factor in the location of such industries as steam making, brewing, distilling, paper making, dyeing, tanning, scouring textiles, laundries, and other industries. Comparatively few cities and towns have complete mineral analyses of their city water supplies. Such analyses as are made generally are limited to the sanitary aspect or the determination of temporary or permanent hardness. Of the 70 city water supplies tabulated by the Bureau of Chemistry, that of Atlanta, Ga., contained the lowest amount of total dissolved mineral matter which was 0.9 grain per United States gallon. This is nearly as low as the standard for commercial distilled water. Bangor Me., Brocton, Mass., Bullochville, Ga., Jacksonville, Fla., Nashua, N. H., New York, N. Y. (Catskill water), Perth Amboy, N. J., Portland, Me., Portland, Oreg., and Springfield, Mass., all showed water supplies containing less than 3 grains of mineral matter per United States gallon.

Unemployment Decreasing.—According to the January industrial survey of the U. S. Employment Service, the reports on employment from 65 principal industrial centers show an increase of 4.2 per cent in the number of workers on Jan. 31 over Dec. 31, 1921. The figures apply to 1,428 firms, employing more than 500 workers each. These concerns employed 1,556,507 workers on Jan. 31 as against 1,493,107 in Dec. 31, a net increase of 63,400. Of the 65 cities 40 reported employment increased during January over December. The largest increase was in Detroit, where the number employed was 59.3 per cent greater, due to a reopening of automobile shops closed for inventory.

Recent Progress in Reduction of Typhoid Death Rate

Interesting statistics on the remarkable progress which has been made in the reduction of the typhoid death rate were given by Prof. C. E. A. Winslow in the American Society of Civil Engineers' Symposium on Water Supply and Water Purification last November. Table I from Prof. Winslow's paper contains typhoid statistics for 1898-1908 and for 1917-1919:

The statistics for this period are compared with those for 1917, 1918, and 1919, in Table I and Table II, shows the distribution of these cities in the two periods, by their grouping in regard to typhoid mortality. It will be noted that in 1898-1908, each of the 35 cities had a death rate of more than 15 per 100,000, and that 17, or practically one-half of them, had a rate of 30 or more. In the last three years, however, only one city of the same 35 has had rates of more than 15, only six have had rates of more than 10, while more than one-third have had rates below 5 per 100,000. This is a truly remarkable achievement and one which is not confined to the cities in question, but which is general throughout the United States.

In Table III are presented the data for the gradually expanding area of the registration states which show that for this unit of area the typhoid rate has dropped in 30 years to less than one-third of its 1890 value. The actual accomplishment is even more striking than such a tabulation would indicate for, as the registration area has increased, it has tended to include more and more cities with relatively primitive sanitary organization. Table IV shows the figures for the registration states as the area existed in 1900, and it will be seen that when the same states are compared, which had a rate of 25.4 in 1900, the rate had fallen to 6.5 in 1916-19, a reduction of nearly 75 per cent.

TABLE I—TYPHOID STATISTICS OF CITIES OF THE UNITED STATES, 1898-1908 AND 1917-1919

City and State	Typhoid death rate per 100,000 population. Average, 1898-1908.*	Typhoid death rate per 100,000 population for 1917, 1918, 1919. (United States mortality statistics) 1917	1918	1919.
Worcester, Mass.	15.3	[illegible]	[illegible]	2.8
Fall River, Mass.	15.7	18.3	[illegible]	3.3
St. Paul, Minn.	16.3	2.6	[illegible]	3.4
New York, N. Y.	17.6	4.2	[illegible]	2.2
Rochester, N. Y.	18.5	[illegible]	1.8	3.4
Jersey City, N. J.	18.5	3.8	[illegible]	2.4
Newark, N. J.	19.2	[illegible]	[illegible]	2.2
Syracuse, N. Y.	19.2	6.1	9.0	7.1
Providence, R. I.	19.5	6.8	5.1	3.8
Milwaukee, Wis.	19.7	6.2	[illegible]	3.7
Detroit, Mich.	20.9	12.7	7.9	5.2
Paterson, N. J.	20.9	12.8	[illegible]	3.7
Omaha, Neb.	23.1	[illegible]	[illegible]	5.3
Boston, Mass.	23.3	3.1	2.6	2.4
Chicago, Ill.	25.3	[illegible]	1.6	1.3
Buffalo, N. Y.	27.0	[illegible]	[illegible]	[illegible]
St. Louis, Mo.	27.7	8.4	7.9	6.6
Scranton, Pa.	28.8	6.6	6.6	1.5
Minneapolis, Minn.	34.9	6.7	8.4	3.2
Baltimore, Md.	35.5	14.4	11.5	8.2
Toledo, Ohio	35.8	8.0	11.2	4.2
Los Angeles, Cal.	36.8	6.0	[illegible]	4.8
Memphis, Tenn.	38.7	26.1	16.2	62.8
Indianapolis, Ind.	39.3	10.5	6.6	4.5
New Haven, Conn.	40.5	10.3	4.4	5.6
San Francisco, Cal.	42.0	4.5	4.2	3.0
Kansas City, Mo.	43.0	12.1	[illegible]	10.9
New Orleans, La.	43.7	23.5	20.0	13.2
Denver, Colo.	48.8	[illegible]	[illegible]	3.5
Cincinnati, Ohio	50.7	4.0	4.8	3.0
Philadelphia, Pa.	53.6	6.3	[illegible]	4.3
Washington, D. C.	55.5	12.2	11.6	3.7
Louisville, Ky.	57.4	16.3	16.3	10.7
Columbus, Ohio	57.5	[illegible]	[illegible]	3.0
Pittsburgh, Pa.	116.9	12.2	10.7	6.5

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*"A Classification and Study of the Typhoid Statistics of the Cities of the United States," by G. R. Taylor.

TABLE II—DEATH RATE FROM TYPHOID FEVER IN CERTAIN LARGE CITIES OF THE UNITED STATES

Distributed by Classes

Death rate per 100,000	Under 5.	5-9.9.	10-14.9.	15-19.9.	20-29.9.	30-39.9.	40-49.9.	[illegible]	100+.
Number of cities in each class, 1898-1908	0	0	0	10	8	[illegible]	[illegible]		1
Number of cities in each class, 1917-1919	12	17	4	1	1				

TABLE III—DEATH RATE PER 100,000 POPULATION FROM TYPHOID FEVER IN THE EXPANDING REGISTRATION STATES FOR DIFFERENT PERIODS BY CITIES AND BY RURAL AREAS, 1890-1919.

Place.	Period Considered 1890	1900	1901-05	1906-10	1911-15	1916-19
Registration states	36.0	25.4	[illegible]	[illegible]	[illegible]	11.9
Cities	39.0	25.3	[illegible]	[illegible]	[illegible]	9.2*
Rural areas	31.4	25.5	[illegible]	[illegible]	[illegible]	13.7

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*Municipalities of 10,000 or more inhabitants in 1910.

TABLE IV—DEATH RATE PER 100,000 POPULATION FROM TYPHOID FEVER IN THE ORIGINAL REGISTRATION STATES FOR DIFFERENT PERIODS BY CITIES AND BY RURAL AREAS, 1900-1919.

Place	Period Considered 1900	1911-15	1916-19
Original registration states†	25.4	11.1	6.5
Cities	25.3	13.0*	6.9*
Rural areas	25.5	8.4	5.8

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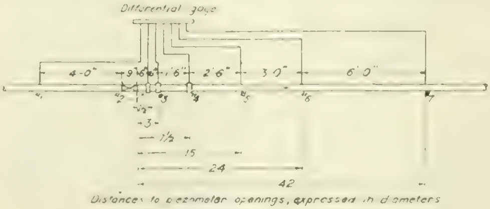
*Municipalities of 10,000 or more inhabitants in 1910.

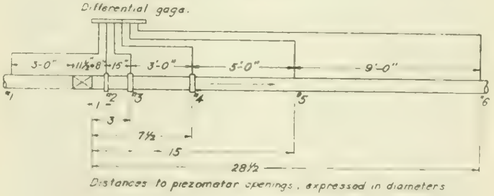
†Connecticut, District of Columbia, Maine, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Rhode Island, Vermont.

Experiments Show Measurement of Valve Loss Dependent on Piezometer Location.

Experiments to ascertain the influence the location of piezometers would have in determining the loss of head due to a valve were conducted at the University of Wisconsin during the school year 1919-1920 by M. C. Neel and C. A. Willson, thesis students. The result of this work are outlined by Charles I. Corp, Professor of Hydraulic and Sanitary Engineering, in the January Wisconsin Engineer, from which the matter following is taken:



4-inch set-up



8-inch set up

Fig. 1.—Arrangement of Apparatus.

The experiments were made with 4-in. and 8-in. gate valves. Figure 1 shows the arrangement of the apparatus. The various piezometer openings along each main pipe were connected to the differential gage board where the head differences could be read.

The apparatus was first set up, in each case, without the valve in place and the loss of head due to pipe friction only determined. The valve was then inserted and the loss for valve and pipe determined for a number of valve openings.

The results from 1/8, 1/2 and wide open conditions for both valves are shown in Figures 2 and 3. To bring out more clearly the difference in loss which would be obtained by using piezometer 1 with 2, 3, 4, etc., the loss as determined from the last piezometer (No. 6 for the 8-in. and No. 7 for the 4-in. valve) has been regarded as the true loss and the loss as shown by the other piezometers divided by this, giving the ratio of the two in each case. It will be seen from Fig. 2 that piezometers located within three diameters distance from the valve give in every case too large a loss, and that in the region from three to fifteen diameters downstream the disturbance of flow has caused the piezometers to register in an uncertain way.

It will be noted also from Fig. 3 the loss is different from the normal pipe friction loss for 10 or more diameters downstream but when a point from 15 to 20 diameters has been passed this loss is negligible from a practical standpoint.

In Fig. 3 the loss of head in each section of pipe between the different piezometers has been shown. This loss as plotted is the difference between the loss when the valve is in position and that obtained for the pipe only.

There is some question concerning the accuracy of the data from which the figure for the wide open 4-in. valve was obtained.

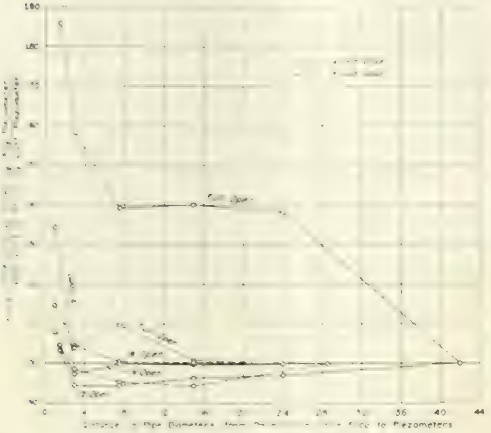


Fig. 2.—Results of Experiments.

The negative value of the loss in section 2-3, 3-4, etc., as shown in Fig. 3 indicates a partial reconversion of the velocity head back into pressure head.

It is concluded that a valve causes disturbed flow in the pipe line downstream for some distance from it and that a piezometer opening which is connected so as to be in this region will be affected, giving a false record of the pressure within the pipe.

Where there is considerable change of section in passing through the valve the pressure head absorbed at that point to produce the higher velocity of flow is partially recovered in the pipe downstream.

Whether the loss of head due to flow through a valve be measured from a piezometer either two or three diameters below the valve the result will be too large. Not until at least 15 or 20 diameters of straight pipe intervene between the valve and piezometer will the reading show the true loss.

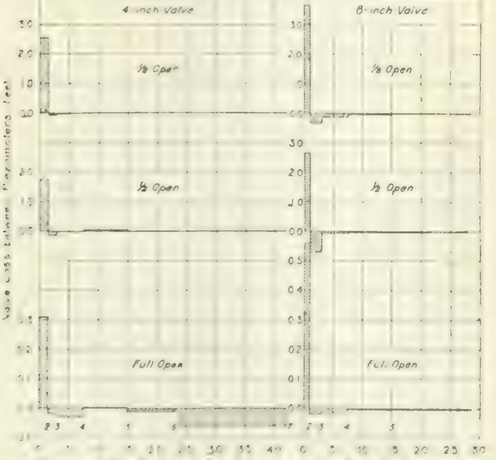


Fig. 3.—Results of Experiments.

Refuse Disposal in Smaller Cities and Towns

An interesting general discussion of present day practice in the disposal of refuse was given by Rolland S. Wallis, Municipal Engineer, Municipal Engineering Extension Department, Iowa State College, in a paper presented Jan. 18 at the annual meeting of the Iowa Engineering Society. An abstract of the paper follows.

The disposal of municipal refuse may be divided into four distinct steps or operations:

(1) House Treatment.
(2) Collection.
(3) Haul to the Disposal Site.
(4) Disposal Treatment.

House Treatment.—The proper house treatment of refuse is an essential in most systems of collection and disposal. When garbage, rubbish and ashes are collected separately the house treatment consists mainly in the separation of these wastes and the placing of each in the prescribed containers properly located for the collectors.

Unless the garbage is to be disposed of by feeding to hogs, it should be drained and wrapped in paper before being placed in the cans. This practice reduces the weight to be handled, aids combustion when incinerated, reduces the smell and unsightliness incidental to collecting and hauling, discourages fly breeding in summer and prevents the garbage from freezing to the containers in the winter. Where the burial method is used the paper wrappings add to the volume to be handled and probably somewhat retard the decomposition of the garbage.

Garbage Collection.—There are five distinct plans which are followed in the collection of garbage:

Garbage Alone: Frequently small cities attempt only the collection and disposal of garbage, leaving the disposal of rubbish and ashes to individual initiative.

Garbage, Ashes and Rubbish Collected Separately: This method gives the greatest freedom as to the method of disposal to be employed. While the separate system complicates and increases the cost of collection, the disposal problem is usually correspondingly simplified, and greater flexibility obtained than with other systems.

Garbage and Combined Rubbish and Ashes: This is another flexible and common system which permits any of the various methods of garbage disposal—the combined rubbish and ashes commonly being used for filling waste land.

Ashes and Combined Garbage and Rubbish: Where incineration is the method of disposal this system is the most common. The fuel value of the rubbish assists in the drying and burning of the garbage, while the ashes are usually disposed of by dumping on waste land.

Collection Agencies.—There are three plans as to the agencies that may be employed in refuse collection: (1) licensed collection, (2) contract collection and (3) municipal collection.

Licensed Collection: Under the licensed-collection plan the municipality licenses certain parties to collect refuse, the cost of this service usually being paid these collectors by the individual householders served.

Contract Collection: Under the contract-collection plan contracts are entered into by the municipality and the collectors for the collection of refuse. Under one form of contract a fixed annual amount is paid by the city for a definite service; under another a definite service fee may be collected from each householder; while under a third the city may be paid for the privilege of collecting, and small fees collected from the householders.

Municipal Collection: Under the municipal-collection plan the city does the work, either with its own or hired equipment.

In general it may be stated that the license and contract systems seldom prove satisfactory in small cities, chiefly due to lack of supervision. The collection of some of the individual fees frequently proves impossible, and irregular service and unsanitary conditions result. Refuse disposal is a true community problem and its cost should be met by a general tax levy.

Municipal collection is usually the most satisfactory. This system is more flexible, as the service can readily be varied to meet fluctuating demands. With municipal collection the scattered collection districts are not slighted on account of the small financial returns and a more systematic operation is apt to result from the use of permanent and uniform collection equipment administered under officials directly responsible to the people.

The successful operation of any collection system demands (a) a sufficient appropriation, (b) an efficient organization, (c) sanitary and economical methods of operation, and (d) the co-operation of the public.

Receptacles. The experience of most cities favors the specification of cans of a standard size which varies with the city and the collection system. They should, however, not be larger than can readily be handled by one man, should be of metal, water-tight and provided with tight-fitting covers not easily displaced.

Collecting Wagons.—Present practice favors special steel tank-wagons provided with either a rear or a side-dumping arrangement. Bottom-dump wagons are not suitable for garbage collection, though they are favored by some cities for the collection of ashes or mixed refuse.

The loading height and the mechanism for dumping are important features, as well as the ease with which they may be cleaned and disinfected. Covers of some sort are essential. Canvas is frequently used, as well as wood and metal. Each type has its disadvantages.

Wagons for the collection of ashes also demand rigidity of construction, but in this case it is more essential that they be dust-tight than water-tight. Rubbish wagons can be of much lighter construction on and of greater capacity than wagons intended for ashes or garbage.

Can-Collection System.—Some cities use the can-collection system, and employ spring wagons provided with double platforms or racks so arranged as to carry two tiers of garbage cans, this usually permitting a load of 60 to 70 cans. The can-collection system has several advantages and has proven satisfactory in a number of small cities. With this system cans of uniform size are essential, and are usually furnished by the city. When a can is collected it is replaced by a steam-cleaned can. This requires but one trip from the wagon, against two when the can is emptied and returned. The difficulty of emptying frozen cans in the winter season is avoided. The garbage wagons are not a nuisance as the garbage is not exposed, and for the same reason the garbage reaches the disposal site in a fresher condition. The can system of collection is more expensive, due chiefly to the investment in cans. With this system sources of careless house-treatment are not readily identified, as the contents of any can are not seen until it is emptied with the rest of the load.

Motor-driven trucks are not favored for collection, and unless the haul is long the transfer of refuse to motor trucks is not economical. Where fairly long hauls are necessary several trailers may be assembled and drawn by a motor truck to the disposal site after having been drawn, individually by horses over the collection route.

Location of Receptacles.—It is customary for city ordinances to specify the place where refuse cans must be left for collection and to what place they are to be returned. These locations should be carefully considered as this decision materially affects the cost of collection.

Cans may be collected from the front curb, the areaways, the rear yards or the alleys. Where alleys are uniformly present throughout the residential districts, this location is practicable and frequently adopted.

An array of cans along the street curbs is unsightly and most householders prefer paying more to have the collectors take the cans from the basements or the rear yards, returning them to the same place. In a few cases this objection to the curb collection is avoided by making collections at night, but day collection may be regarded as the prevailing practice. Some cities require that cans shall not remain in the street more than, say, one hour after being emptied, but a lack of co-ordination is always likely, especially when the collections are not made on schedule.

Frequency of Collection.—The interval between collections depends upon various factors, particularly the density and character of the population, the method of disposal and the season of the year. In northern cities garbage production reaches its maximum during the summer months, while the production of ashes is naturally greatest during the winter season. In general, more frequent collection is necessary as the congested portion of the city is approached.

In the residential districts of most cities two or three garbage collections per week are made throughout the summer season, and one or two per week during the winter months. In business districts daily collections are common. Where hog-feeding is practiced, collections should be made daily during the hot summer months, and about twice a week at other times.

Manure should be collected twice weekly during the fly season, as only about four days are required for the development from eggs to maggots, which then leave the manure to enter the ground there to complete their development into full-grown flies.

Collection Regulations.—The house treatment and the collection of house refuse should be regulated by the adoption and enforcement of ordinances covering

a. The establishment of municipal refuse collection.
b. The forbidding of collection by unauthorized parties.
c. The definition and classification of refuse.
d. The house treatment to be employed.
e. The refuse receptacles to be used, and their location for collection.
f. The frequency of collection, and the equipment and sanitary measures to be used.
g. The jurisdiction and authority of city employes who handle the refuse or supervise its disposal.

Regularity in service is claimed to be the greatest aid in securing the necessary co-operation of the householders. Any new system or changes in schedules should be preceded and accompanied by a carefully planned educational campaign.

There are a number of methods available for the disposal of refuse. Each of these will be briefly described and its field defined.

Dumping Into Large Bodies of Water.—The use of this method is naturally restricted to cities located on the seacoast, or on the larger lakes or streams. This use of the Mississippi River having been forbidden, the method no longer applies to Iowa cities and it is only mentioned for completeness.

While the method is economical, flexible and available for all kinds of refuse, the objections incidental to its employment are such as to cause it often to be abandoned even where feasible. Chief of these objections are the pollution of the water and the unsightly and malodorous deposits that are apt to be brought to the shores by the action of wind and water currents.

Dumping on Land.—The simplicity and universal application of this method to nearly all sorts of refuse and local conditions accounts for its wide use. The feasibility of dumping refuse materials on waste or low land depends largely on the character of the refuse, the proximity of residence districts, and the care with which the dumps are managed.

Street sweepings, material from excavations, ashes, rubbish and solid manufacturing wastes can be disposed of in this manner without the creation of any appreciable nuisance.

Rubbish is the least desirable of these filling materials. It is of little value for this purpose, and being combustible is frequently burned to lessen its volume, a nuisance thus being created in the form of smoke and odors. The presence of a limited amount of rubbish having commercial value invites the picking over of such dumps, an undesirable practice which should be prevented, but which requires careful policing to control.

The reclamation of low and waste city land by filling has made possible many attractive park and playground sites. The value of such filled land frequently is such as to render this method of disposal distinctly advantageous to a city.

The disposal of garbage, night-soil or dead animals by dumping is a crude make-shift at best and is sure to create a nuisance in almost any district, as well as to attract and afford breeding places for flies and rats. Long hauls are usually necessitated, and the method is universally condemned. As to the legal aspects, it is well established that a municipality cannot, without liability, create a nuisance by the operation of a dump.

Burial.—The method of burial is simple and especially applicable to the disposal of garbage, night-soil, and dead animals. An open sandy soil is desirable where the water table remains well below the burial depth. As applied to garbage disposal, long, shallow trenches are excavated about 5 ft. wide and 18 in. deep. The garbage is spread in these trenches in a uniform layer not to exceed 1 ft. in dept, and promptly covered with a layer of earth of equal thickness obtained from the excavation of a parallel trench.

This method removes the garbage from sight, prevents any extensive fly nuisance largely eliminates objectionable odors and is economical. While the loose earth covering is sufficient to prevent odors, enough air is admitted to assist the decomposition of the garbage, so that in open soils it requires about two years. With such soil and an average amount of garbage the continuous operation of this method requires about one acre of land for each thousand people served.

Winter operation may be facilitated by the use of ashes or street sweepings hauled in as a temporary covering. The trenches necessary should be opened before freezing weather sets in.

This method is one that should be given serious consideration by the small city desiring an economical and satisfactory garbage disposal system. For large cities the long haul and the relatively large amount of land necessary usually render the method inapplicable.

A variation of the shallow burial method consists in spreading a thin layer of garbage over the surface of the ground, the refuse being both buried and mixed with the soil by the intermittent operation of plowing it under the surface. This method frequently creates a nuisance, for, unlike trench burial it is impracticable to cover the raw garbage as it is delivered. More care is needed to thoroughly cover the garbage and some hand work is usually necessary. This method affords a satisfactory disposal for street sweepings.

Night-soil is best buried in ploughed furrows, being immediately covered by turning soil from a parallel furrow over it. By this method under ordinary conditions, about 1½ acres of land are required for each thousand people served. Poor land is improved by this treatment, but it should not be cultivated for a year or more after such use.

Sanitary Fill. The disposal method known as "sanitary fill" may be looked upon as a sort of cross between the dumping and burial methods. As usually carried out it is essentially the dumping method made applicable to garbage by the prompt mixing and covering by hand methods with earth from excavations, ashes or street sweepings, these materials being delivered at the disposal site for this purpose. The garbage is given a thin covering equivalent to that used in the shallow burial method, care being taken to use sufficient earth to mix with and thoroughly cover the garbage. Very little odor or other nuisance need result from the use of this method if carried on properly.

Davenport has used this method for a number of years, creating valuable water-front land. Seattle has employed this method for several years, no use being made of their three incinerators. Mr A. H. Dimock, the city engineer, has recently stated that when the cost of haulage becomes excessive, or more than the cost of burning they may return to the method of incineration, but in his judgment, it will be many years before this happens.

While this method is applicable to nearly all sorts of municipal refuse, a large proportion of rubbish is objectionable. This is chiefly on account of its bulk and the large proportion of combustible material usually present, which if ignited is apt to cause a nuisance, as well as slow-burning fires sometimes very difficult to extinguish.

Feeding to Hogs. Garbage has always been disposed of. The feeding of garbage on an extensive scale received a decided impetus during the war as a conservation measure, and with careful management and favorable conditions the operation of such hog farms has often proved very profitable. Under average conditions it is not likely that the value of the garbage will prove sufficient to pay the entire cost of collection and haul, plus a profit, so that cities can hardly expect to derive a revenue from their garbage, or even to have it collected and disposed of without cost.

Experience indicates that about 50 lb. of garbage are ordinarily required to produce a pound of pork, live weight. Using this fact as a basis the gross value of garbage is easily computed. From this must be taken the operation costs, together with the interest and depreciation charges on buildings and equipment.

Garbage for hog feeding should be delivered fresh, and free from the various injurious materials (such as glass, tin cans, paper, rags, sawdust and soap) which are ordinarily present. The exclusion of these materials should be required by ordinance and furthered by a careful campaign of education for the public. The exclusion of dish water is especially important as it is apt to contain soap and cleansing chemicals injurious to the digestive apparatus of the hogs.

Hog farms are best located on open, easily drained soil. An abundant supply of drinking water is especially important in the case of garbage-fed hogs. The acreage needed depends on the system employed, as well as on the number of animals handled.

The best practice seems to favor the feeding of garbage from platforms. These are sometimes constructed permanently of concrete, or more frequently of wood and so designed that they may be skidded readily from one location to another, each site being vacated and plowed under when it becomes muddy and insanitary. Such plowed areas are often planted to some forage crop for the hogs.

Most breeds of hogs have been successfully fed on garbage. Some feeders purchase hogs at about 100 lb. weight, while others prefer the policy of raising their feeders on garbage, thus accustoming their digestive systems to the greater bulk of the garbage ration. Little supplementary feeding is practiced in most cases, except as a finishing ration before marketing.

Winter operation introduces the problem of frozen garbage, which is preferably thawed before feeding. Cooking or sterilizing the garbage is sometimes practiced but is not looked upon with favor as it is expensive, prevents natural food selection being exercised by the animals, and causes injurious acids and other soluble substances to be spread throughout the cooked mass.

The chief objections offered against this method of garbage disposal are (a) that incomplete consumption involves the disposal of the rejected portions, (b) that there is difficulty in delivering garbage in a fresh condition; (c) that the method is still somewhat experimental; (d) that it is apt to create a nuisance, and (e) that there is always danger of the loss of the herd by disease, thus crippling the disposal system of the city.

The various claims that garbage feeding does not produce good pork, that trichinae are more frequently found, and that the hogs are more subject to cholera and tuberculosis, have not been borne out by experience. Innoculation against cholera is usually practiced.

The success of garbage feeding depends on (a) public co-operation in the matter of house treatment, (b) frequent and efficient collection and largely on the (c) skill and intelligence of the manager of the hog farm. The method is of especial interest and value to small cities and towns.

Sorting.—Rubbish always contains material of commercial value, and the sorting out of such materials has been tried out by several large cities, the amount recovered by the sale in most cases rather more than covering the cost of sorting. This practice would seldom prove an economy in small cities and towns.

Incineration.—The method of incineration consists in the destruction of refuse by burning, the combustible solids and the contained moisture being dissipated in heat, steam and various gases. The ash or clinker that remains is suitable for filling land.

Most incinerators are intended mainly for the destruction of garbage, but rubbish is commonly added to furnish at least a part of the combustible material needed to dry the garbage. Drying is usually effected by contact with the hot gases of combustion, after which the dried garbage is introduced into the combustion chamber.

Incineration, if accomplished at a high temperature and at a rapid rate, is a sanitary and expeditious method. Garbage incinerators of modern design can be operated without nuisance. The plant location now depends more on hauling costs than on any necessity for securing an isolated site.

The heat produced by the incineration may be utilized in the generation of steam for power purposes, but this practice is seldom an economy except in large plants that are operated continuously.

The initial cost of an incinerator, together with the relatively high cost of operation, constitutes a heavy financial burden for the average small city or town, and the relative costs and advantages of the methods of burial, sanitary fill and hog feeding should be carefully investigated before the construction and operation of an incinerating plant is undertaken.

The use of small individual incinerators of simple construction has been suggested as a practicable disposal method for use in outlying districts where dwellings are scattered and the cost of refuse collection and handling is relatively high. With the excess of combustible material usually present, garbage is readily dried and burned with little ash or odor. It must be confessed that for such conditions this plan has pronounced economic and sanitary features.

Reduction.—Briefly stated, garbage disposal by reduction or rendering involves the extraction of the grease, the removal of the water content and the preparation of the dried residue or tankage for use as fertilizer or as animal food. Dead animals are conveniently and economically disposed of by this method.

The process of reduction, while disposing of the garbage, make a definite return in the commercial value of the grease and tankage produced, but the various patented processes are relatively complicated and expensive to install and to operate, and do not prove economical for cities having populations under 100,000. The method is not then, generally applicable to Iowa conditions and will not be considered in detail.

The operation of reduction or rendering plants is seldom, if ever, entirely free from odors, and frequently these are very objectionable and noticeable at long distances. While about half of the reduction plants constructed in this country have been abandoned.

General Requirements National Board Fire Underwriters Regarding Water Works*

By ROBT. E. ANDREWS.

Assistant Chief Engineer, National Board of Fire Underwriters, San Francisco, Calif.

The Baltimore conflagration of 1904 was the immediate cause of the entry of the National Board of Fire Underwriters into municipal affairs on a large scale. During the 14 years previous to that date, a large number of reports on cities had been prepared by single inspectors, usually fire chiefs of long experience, and, as was natural from their training, little space was devoted to waterworks. The Baltimore fire caused a direct property loss of $50,000,000 and aroused the insurance companies to the possibility of similar fires in other cities.

This conflagration was carefully studied from many angles and the preparation of reports on all the large cities of the United States was begun in a systematic way. Instead of single inspectors the work was carried on by parties composed of engineers specially trained in the branch of the work they were to handle. In addition to description and criticism of water systems, the reports outlined fire departments, fire alarm systems, actual structural conditions and laws and ordinances relating to building and to fire hazards —all leading up to a discussion of the possibility and probability of a conflagration—and followed by recommendations for improving conditions thought to be unsatisfactory.

Fire Protection Engineers Pioneers.—The engineers preparing these reports were pioneers in a new line. There were no fixed standards by which a water system, or the other features considered, could be judged from the fire protection point of view. What standards there were in regard to these matters, were the results of opinion rather than of experience. That the reports did not go far wrong is shown by the one issued on San Francisco in October, 1905, in which the catastrophe of the following April is vividly foretold. This conflagration, with a property loss very greatly exceeding that of Baltimore, again emphasized the importance of the work, and brought home to the insurance companies the immense aggregation of values which can be destroyed by a single fire. Except for the period of the war the issuing of reports on the larger cities of the country has gone on without interruption. Usually about 35 reports are published each year. Copies of the printed report are sent to city officials, civic organizations such as Chambers of Commerce, Rotary and Kiwanis Clubs, to newspapers and to influential citizens particularly interested in fire protection.

300 Cities Reported On.—By 1916 approximately 300 cities had been reported on, some of them three times. The amount of information acquired in the prosecution of this work was enormous. Enough data were on hand so that careful studies could be made of the various features upon which effective fire protection depended. Conditions in one city were compared with those in others of the same class. Conclusions were no longer based on opinion but on the results of many years of experience. If, for example, we asked that a distribution system be composed of mains of certain size, it was because thousands of tests had told us that suitable quantities of water for fire protection could not be obtained unless the mains were of the sizes recommended.

In fact, we had so much information in our files and had acquired so much experience in this particular field, that we felt justified in taking an ambitious step forward—namely, grading cities with reference to their fire defences and physical conditions. Up to this time, the work of the National Board of Fire Underwriters had been confined almost entirely to the larger cities. It was felt, however, that any system of grading which might be adopted, should apply equally well to cities and towns of all sizes. Accordingly, an intensive study was made of a large number of small towns and villages, and the standards modified, where necessary, so that all would be considered with equal fairness.

Grading Cities with Reference to Fire Defences.—The plan adopted is like that of marking a school-boy's examination paper, where so much is taken off for every mistake. The sum of the maximum points of deficiency totals 5,000 and is divided in accordance with the relative values of the features as follows:

	Points
Water supply	1,700
Fire department	1,500
Fire alarm	550
Police	50
Building laws	200
Hazards	300
Structural conditions	700
Total	5,000

That is, a city where the fire defences and physical conditions are excellent would have few points of deficiency, and one where conditions are as bad as possible would approach 5,000 points. The water supply is given a weight of about one-third of the total requirements. It is considered as being of slightly more importance than the fire department, as a water system is of some value for fire protection where there is no organized fire department, but a fire department without water is almost helpless. A good water supply in connection with a poor fire department, or vice versa, is obviously of less value than if both are good. In recognition of this fact an equalizing charge is made where the two features differ greatly in efficiency.

The Grading Schedule has been received with marked enthusiasm. A number of engineering societies, some of them national in scope, have investigation the schedule and given formal approval. Insurance rating organizations use it for classifying cities and towns in all states of the Union except in Texas, New Jersey, part of Pennsylvania and on the Pacific Coast. Its use for this purpose precludes any possibility of discrimination and allows every town to know in what respect and to what extent its fire defences are deficient. As a guide for outlining improvements for fire protection it is invaluable.

Viewpoints in Judging a Waterworks.—A waterworks is judged from two viewpoints, adequacy and reliability. To be considered adequate, a system must be capable of supplying a reasonable quantity for fire protection for a period of 10 hours, in addition to domestic consumption at the maximum daily rate. It is frequently suggested that we ought to base our calculations on the maximum hourly rate instead of the maximum daily rate. We feel, however, that it would be going to the extreme to assume that a serious fire would occur exactly at the peak hour of the highest day. Fires of the magnitude with which we are chiefly concerned ordinarily burn for a longer period than the duration of the peak hour. There is always the possibility that citizens may suspend lawn sprinkling during a large fire and that water works' officials may operate gate valves so as to reduce the flow to parts of the city remote from the fire; both of which would reduce the domestic consumption. Furthermore, pressures are naturally reduced in the vicinity of a large fire, and sometimes the area affected is of sufficient size to cause a noticeable decrease in consumption. For these reasons we think it preferable to use the maximum daily rate.

Quantity of Water for Fire Protection.—The quantity asked for fire protection in the central business district, is usually that determined by a formula based on population, which was worked out by Metcalf, Kuchling and Hawley. The quantities required are shown in the following table.

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*From a paper presented Oct. 1 at the second annual meeting of the California Section of the American Water Works Association.

Population	Required fire flow, gallons per minute for average city	Population	Required fire flow, gallons per minute for average city
[illegible]	1,000	[illegible]	5,000
[illegible]	1,500	[illegible]	6,000
[illegible]	2,000	[illegible]	7,000
[illegible]	2,500	[illegible]	8,000
[illegible]	3,000	[illegible]	9,000
[illegible]	3,500	[illegible]	10,000
[illegible]	4,000	[illegible]	11,000
[illegible]	4,500	[illegible]	12,000

When the population exceeds 200,000 provision should be made for two fires occurring at the same time, and we ask for 12,000 gal. a minute for the larger fire and from 2,000 to 8,000 gal. for the second fire. The total quantity in all cases includes an allowance for loss from broken connections and hydrants left open, incidental to a large fire.

Occasionally the quantity indicated by the formula is modified as required by unusual local conditions. For example, in the vicinity of large cities there are generally suburban communities having good sized populations but with mercantile districts of very small area and without congested construction in comparison to the population. Obviously to require the average fire flow in this case would be unfair. Conversely, there are cities of small population, remote from other cities, which are surrounded by thickly settled rural territories and which are in fact the mercantile center of a population several times that within the municipal limits. Such cities require more than the average fire flow.

The time limit of 10 hours required for the fire flow has been determined upon as closely approximating actual needs. Nearly all conflagrations have lasted must longer than this—some of them ten times as long. The use of water, however, begins gradually and increases for several hours as more lines of hose are brought into play. The peak load ordinarily continues several hours and as the fire is brought under control the quantity gradually becomes less. Ten hours of full fire flow probably amounts to the average quantity of actual flow at the variable rate. For towns under 2,500 population the time limit has been reduced to 5 hours.

In speaking of the fire flow required, I characterized it as being reasonable. It is merely the quantity which good practice demands should be available and not that which might be needed under the most extreme conditions. In the Baltimore conflagration water was actually used at the rate of 33,000 gal. a minute, yet in our reports we have asked only that 12,000 gal. a minute should be available about any block in the congested business section, with 6,000 gal. a minute additional for a second fire occurring at the same time. A few months after our report on Hartford, Conn., was issued, in 1916, a fire occurred at which water was used at exactly the rate we requested. This fire did not spread outside the building in which it originated, and was very much smaller, so far as water needs are concerned, than other fires which are probable. For four hours during the Atlanta conflagration in 1917 water used on the fire was at the rate of 13,000 gal. a minute, yet the fire occurred in a residential section for which we modestly asked 2,500 gal. a minute about any block. Examples like these could be multiplied indefinitely. If there is any error in the quantities we recommend, I believe it is in not asking enough.

Reliability of a Water System.—The second viewpoint by which a water system is judged is reliability. In general, reliable fire protection requires duplication of such parts of a water system as may reasonably be expected to become inoperative. Aqueducts of good design and of substantial construction, such as masonry or concreted steel, are considered sufficiently dependable as not to require duplication.

It is recognized that a so-called gravity system—one delivering supply direct to the city from the source without the use of pumps—is preferable from a fire protection standpoint, but a well-designed and properly safeguarded direct pressure system, such as the high pressure fire systems of some of our large cities, so nearly approaches the gravity system in adequacy and reliability that no distinction is made between the two types.

The introduction of storage, either elevated and supplying the distribution system or for suction supply, offsets to a greater or less degree the need of duplication in various parts of a system, the value of the storage depending upon its amount and location. In general, all storage lessens the requirements of those parts of the system through which the supply has already passed. It is assumed that storage adequate to meet maximum consumption demands for five days plus fire flow for ten hours, is sufficient to permit the making of most of the repairs, alterations or additions incident to the operation of a water supply system. Where storage fluctuates materially during the twenty-four hours, the minimum storage maintained is used in all calculations. In no case is a rate greater than the actual capacity of the mains from the reservoir considered. Owing to the decrease in pressure when water is drawn down in standpipes, only the capacity of the top twenty-five feet is considered as effective storage, unless the standpipe is on elevated ground and fire engines are generally used.

Principal Requirements in Grading Water System.—In grading a water system deficiency charges are made under 32 separate headings. Briefly stated, the principal requirements are as follows:

The chief executive, either superintendent or chief engineer, shall be competent and qualified by experience. Employees shall not be subject to removal by every incoming political administration. Records and plans shall be such as to facilitate repairs and to permit the efficient operation of the system. Emergency crews shall be quickly available. Fire alarms, particularly in direct pressure systems, shall sound in appropriate water works quarters.

Two items are of fundamental importance and may have very heavy charges. The first is based on the normal ability of the source of supply, including impounding reservoirs, and all parts of the supply works, to deliver the required quantity to the district being considered. The second is the reliability of the source of supply. Under supply works we include intakes, suction lines, pumps, boilers, stacks, air compressors, filters and force or supply mains. The extent of deficiency of each part of the supply works is considered and the percentage of deficiency of the most serious is used for computing the charge. Under reliability we consider such items as frequency and duration of droughts, physical condition of intakes, danger from earthquakes, floods, forest and grass fires, ice dams and other ice formations, and silting up or shifting of channels.

Pumping capacity must be such as to allow two pumps in reserve. The deficiency charge, however, is very small for the second reserve unit and is still further reduced for small cities. In cases where both low-lift and high-lift pumps are provided and reliability of supply is dependent on both, they are considered separately, and, if necessary, charges are made for each. Boiler capacity with a reserve of one-fourth the entire capacity, and in any case at least one boiler, must be sufficient to operate the pumps and auxiliaries required. Electric transmission lines, steam piping, or gas or oil piping to internal combustion engines or boilers, shall be so arranged that a failure in any line, or the renewal of a valve, transformer or oil pump, would not prevent maintaining, in connection with storage, maximum domestic consumption for two days and fire flow for ten hours. Pumping stations and other portions of the plant shall contain no combustible material in their construction, shall be protected from exposures and have suitable private fire protection. When pumps are electrically operated the generating station supplying them should have the same features of reliability that are required in the pumping station.

Although aqueducts of substantial construction are not required to be duplicated, suction or gravity lines to pumping stations, flow lines from reservoirs, force mains, etc., shall be of such capacity and so laid out that no single break will prevent the delivery of the required quantity. Such lines shall be laid as not to endanger each other, and their failure at stream crossings, railroad crossings and other points where physical conditions are unsatisfactory shall be guarded against. In connection with supply mains, there must be arteries and secondary feeders of sufficient size extending throughout the distribution system. The gridiron shall be made up of minor distributors, 6 in. or larger in diameter, connected at intervals not exceeding 600 ft. and free from dead ends. These charges, however, are reduced where pressures are high. In other words, it is a certain quantity of water that is wanted, rather than a strict adherence to a rule. Pipe in unreliable condition, whether cement-lined, wood or metal, is charged for.

The distribution system shall be equipped with a sufficient number of gate valves so located that no single case of accident, breakage or repair to the pipe system will necessitate the shutting from service a length of pipe greater than 500 ft. in high value districts, or greater than 800 ft. in other sections.

The requirements for hydrant spacing are based on the assumption that hose lines shall not exceed 500 ft. in length when laid directly from hydrants, and 600 ft. in length when supplied by fire engines. The unit of measurement which has been adopted for determining hydrant spacing is the area served by each. The area required depends on the quantity of water which the fire department may be called upon to handle. In the largest cities the average area served by a hydrant in the congested district shall not exceed 40,000 sq. ft., but in villages where a fire flow of only 1,000 gal. a minute is asked for, an average area of 120,000 sq. ft. is permissible. Hydrants shall be maintained in good operative condition, shall be of such size and type as to deliver 600 gal. a minute with a friction loss of not over 2½ lb., and connections to mains shall be gated.

I imagine some of you will say it is well to aim high. I admit that our standards are high, but they are by no means unattainable. The very fact that so many water systems approach complete compliance shows that our requirements are not excessive. Of sixteen cities on the Pacific Coast, on which the National Board of Fire Underwriters have recently issued reports, three have water works which may be considered as 90 per cent perfect from the standpoint of fire protection. One grades as high as 95 per cent.

Direct Billing by Meter Readers Cuts Cost for Power Co.

Three years' experience by the Livingston branch of the Montana Power Co., with direct billing of consumers by meter readers, has demonstrated that the system employed has many advantages and shows a considerable saving over the one formerly used. The methods were described by Mr. J. R. Kaiserman, manager, Livingston Branch, in the Electrical World, from which we have taken the matter following:

Under the old method of billing the meters were read by the meter reader and the readings entered and figured in the consumers' ledger. From this the bills were prepared, put in envelopes, stamped and mailed. Unless a window envelope was used it was further necessary to address the envelope. Several days after the meters had been read the bills were delivered by the postman, who covered virtually the same ground as had the meter reader. As the entire procedure was wasteful an effort was made to eliminate all unnecessary duplication.

The first thing was to eliminate the meter readers' record book. It was found that the addressing-machine plate could easily supply the necessary information such as the company's serial number for the meter to be read. This number is either on an aluminum tag attached to the meter, under one of the binding nuts on the face, or is placed on the meter by a rubber stamp which imprints the number on the dial plate. Following this number a letter, or combination of letters, is the key denoting the meter location, and following this is a numeral signifying the classification of the consumer. This latter classification number denotes the kind of service which the meter records. The meter readers' routes are laid out to make the walks as short as possible, so that no unnecessary overlapping is done, and the consumers' accounts are arranged to coincide with the route taken by the meter readers.

In the plan now in use the bills for a certain route are run through the addressing machine in the same order as found in the ledgers, and necessary information is written on the bill, such as the previous reading and date, the meter constant and readiness-to-serve charge (if any), the balances due, and, in the event of power users, the fixed charge and the corresponding rate.

The meter reader (better called the outside office man) is now ready to start on his route to read meters, compute the bill and leave it with the consumers. The bill is thus rendered several days sooner than by the old method. No attempt is made by this man to collect the amount of the bill, as we wish to have our consumers come to the office, where appliances are on display.

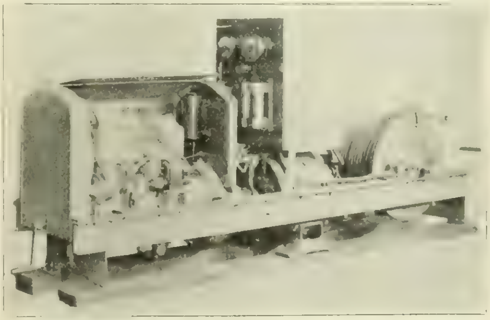
The stubs, bearing copies of the bills left with the consumers, are then returned to the office and placed in a file near the cashier's window. When the consumer produces his bill to make payment the route and serial number are noted by the cashier and the corresponding stub is quickly located. Before closing the day's business the cash receipts are listed by the route and serial number to check against the cash, and the following day these stubs have their new data posted on the consumers' ledgers. In one operation the new reading, the date of reading, the kilowatt hour consumption, the amount of the bill and the amount paid, as well as the discount allowed, are all posted. It is found that approximately 90 per cent of the bills are paid within the 5-day discount period allowed. The bills unpaid within that period are posted from the stubs left in the cashier's file.

The advantages shown are these: The meter-record books are eliminated; the time necessary for transcribing the readings to the ledgers is saved; there are no bills to prepare from the ledgers and no placing of bills in envelopes, stamping and mailing; bills are in the hands of the consumers three to five days earlier than before, and accounts are collected much sooner. An advantage noted by the cashier is that it is no longer necessary to run through the ledgers to see what accounts are unpaid. As long as any stubs remain in the file he knows that they represent unpaid accounts, and delinquents are easily followed up.

Another advantage is that where the meterman has no record of previous readings for several months back to indicate the usual monthly consumption of energy, he becomes more efficient in reading meters as he does not have anything to serve as a guide and has no opportunity to "guess" the reading. We now find it extremely seldom that an error is made in readings as the meter readers have been trained to become more accurate and self-reliant.

Electric Unit for Thawing Water Services

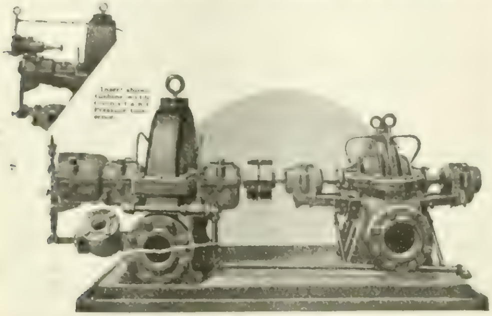
A gas-electric unit which has given good service to the Water Department of St. Paul, Minn., is illustrated below. According to the 37th annual report of the Water Commissioners of that city, this unit thawed out 1,200 service connections at an average cost of $2.83 per service. The thawing operations took from 5 minutes to 15 minutes, the average being less than 10 minutes. The outfit consists of one "Capitol" 4 cylinder motor, 35 H.P., directly connected to a 20 K.W. generator. The engine is governor controlled. The generator current is controlled by suitable switch, fuses, rheostat, volt and ammeters, all suitably mounted on a substantial panel above the generator. The current from the generator to the service pipe in the building or service connection is conveyed by flexible cable which is carried on the reel when not in use, final connections being made by universal clamps. The reel has commutator on one side connected to generator and carries 400 feet of cable to connect to nearest fire hydrant or main connection. The necessary amount of cable may be reeled out as required. The dimensions are: Length over all, 10 ft.; height to top of instrument board, 4 ft. 6 in.; height to top of radiator, 3 ft. 6 in. The unit weighs approximately 2,800 lb., and is self contained except the gasoline tank, which is carried separate and connected to carburetor by vacuum system. Its operation is taken care of by motor truck driver and helper. This thawing outfit is manufactured by the Auto Engine Works, St. Paul, Minn.



Unit to Be Mounted on Truck for Electrically Thawing Water Service Pipe.

New Steam Turbine Driven Centrifugal Pump

A new steam turbine driven centrifugal pump has been added to the line of the Goulds Manufacturing Co., Seneca Falls, N. Y. The unit consists of Goulds centrifugal pump direct connected to a Lee steam turbine. The latter is of the [illegible] stage multiple impulse type. This outfit can be shipped from stock as complete units assembled and [illegible] ready to install. The turbines are fitted with constant speed governors. In addition constant excess pressure and constant pressure governors can be furnished. These steam turbine driven pumping units are stated to be particularly adapted for boiler feeding, hot water heating, brine circulating, condenser work, tank filling, fire protection, general [illegible] supply, etc. The units are furnished in various sizes. The standard sizes and capacities for the general service outfits are as follows:



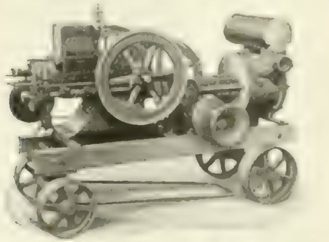
Goulds Steam Turbine Driven Centrifugal Pump for General Service.

Pipe sizes		Approximate capacity gallons per minute.		Maximum Pressure or head.
Discharge	Suction			
in.	in.	Minimum	Maximum	
[illegible]	3	100	375	65 lb
[illegible]	5	200	800	or
[illegible]	6	350	1,000	150 ft.
[illegible]	8	600	1,500	
[illegible]	10	1,400	2,400	

Larger sizes [illegible] can be furnished.

New Double Acting Force Trench Pump

A new double acting force pump unit designed especially to handle dirty water found in trenches, sewers, manholes, excavations, cofferdams, mines, etc., has been placed on the market by the Domestic Engine & Pump Co., Shippensburg, Pa. The pump is of the displacement piston type with stationary water sealed packing rings. The unit is fitted with a winch head, capable of giving a single line pull of 500 to 600 lb., which can be used for lowering or lifting material out of trenches, or for many other purposes. The pump has a [illegible] cylindrical plunger packed with ordinary water plunger packing. In case of necessity pump can be packed with [illegible] and unwound strands of hemp or manila rope, [illegible] the user against expensive delay. The unit is made in two sizes: one with a 2 H.P. engine, a capacity of 3,000 gal. per hour, and a net weight of 1,000 lb., and the other with a 4 H.P. engine, a capacity of 6,000 gal. per hour, and a net weight of 1,300 lb.



Trench Force Pump Unit with Winch Head

Obituary

George W. Jackson, engineer and contractor, died at Evanston, Ill., on Feb. [illegible], following a brief illness with pneumonia. From 1883, when Mr. Jackson began his career as a contractor at the age of 22, his work centered at Chicago, but it also extended as far as New York and Colorado. He has often been referred to as a picturesque character, but he was more than that: he was a man who "did things," who had his mistakes and failures, but mistakes of the sort made by a man of large spirit rather than by one who fears mistakes and who is overburdened in his efforts to avoid them.

Mr. Jackson's most important and best known work was probably the construction of Chicago's [illegible] miles of freight tunnels. He built the Strickler [illegible] through Pike's Peak, sewer and drainage systems in Chicago, and several bridges. He installed 91,000 ft. of pneumatic tube system for the Associated Press of Chicago and about [illegible] per cent of the underground systems of the Illinois Bell Telephone Co., Postal Telegraph & Cable Co., and Western Union Telegraph Co. in the same city. Between 1882 and 1911 his work totaled about $100,000,000.

He undertook to build a land and lake tunnel at Seventy-third St. to cost $1,800,000. At the same time he contracted for construction of the Yonkers pressure tunnel, Catskill aqueduct, a part of the New York City water supply system.

He had planned using the same machinery on both "jobs," but an accident at Seventy-third St. so badly delayed completion of that project he was forced to invest in new machinery for the New York work. This was more than he was able to carry financially, and in 1911 his company went into the hands of a receiver. It is said that Mr. Jackson's personal loss in the failure was about $1,[illegible].

From that time he directed his efforts to "coming back," organized the George W. Jackson [illegible] Co., and at the time of his death appeared well on the road to success. Mr. Jackson's inventiveness was always a factor in both his earlier and later work, and many of his machines were of his own devising.

Whether rightly or wrongly, Mr. Jackson has long been credited with a peculiarly astute action in the Chicago freight tunnel undertaking. Before the commencement of work, a corrupt political group was attempting to extort a large sum for the concession. To circumvent this action, Jackson began work secretly in the basement of a loop saloon [illegible] completed the excavation of 16 miles of tunnel before the [illegible] discovered the trick. His workmen passed in and out of the saloon in the guise of patrons, and the earth was removed [illegible] when the saloon was closed after midnight. Jackson himself was never seen about the place. When it was learned that 16 miles were completed serious opposition was dropped.

During the past 2 years Mr. Jackson served the city of Chicago as an expert on street [illegible] operation, a work for which the editor of Engineering and Contracting felt that he was ill equipped. But this fact does not [illegible] the esteem of his many admirable qualities. He was a man [illegible] was good to know, and who will be truly missed from the construction field.

Industrial Notes

Dayton-Dowd Co., [illegible], Ill., announce the opening of a district office in Pittsburgh at [illegible] Keenan Bldg., covering the sale of centrifugal pumps and underwriters' fire pumps. The office will be in charge of T. J. [illegible], who for the past several years has been connected with the [illegible] office on engineering and sales.

At the annual meeting of the Lakewood Engineering Co. Charles F. Lang retired from the presidency. The company is now officered and managed by men who have been connected with it for many years. Reports from the sales force show every indication of a general betterment and increase of business in all departments, particularly in the paving and general construction fields. It has already been necessary to increase the factory force to meet the improved demand.

The Kennedy Valve Mfg. Co. has made the following changes in its organization: H. [illegible] has been appointed assistant to C. A. Burgess as traveling representative with headquarters at Elmira, N. Y. James F. [illegible] has been appointed assistant to S. C. Mead, Chicago branch manager. John J. Milliken, who has formerly been in the Chicago office, has been appointed assistant to E. H. Kouns, Eastern sales manager. An additional office has been opened in the L. C. Smith building, Seattle, Wash.

The Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., announces that T. H. Hays has been appointed manager of the Indianapolis, Ind., office of the company. Until further notice, A. E. Hitchner, assistant to the manager, Industrial Department, in general charge of the mining and electro-chemical industries, will have general charge of the sections formerly handled by W. H. Patterson, who recently resigned as assistant to the manager of the Industrial Department to accept the position of vice president of the Kaestner & Hecht Company, Chicago, elevator manufacturers.

An agreement has recently been reached between the East Jersey Pipe Co. and the Riter Conley Co. whereby "Lock Bar" steel pipe, which has been exclusively controlled by the East Jersey Pipe Co. since its introduction into this country in 1905 and has been hitherto manufactured by the East Jersey Pipe Co. at its plant at Paterson, N. J., will be hereafter fabricated in the Pittsburgh district by the Riter Conley Co. at its Leetsdale plant. This is regarded as a step forward by both parties as it will permit considerable saving in freight rates and economy in manufacturing. The sale of "Lock Bar" steel pipe will continue to be exclusively in the hands of the East Jersey Pipe Co.

Trade Publications

The following trade publications of interest to engineers and contractors have been issued recently:

Pumps and Supplies.—A. D. Cook, Lawrenceburg, Ind. Catalog of the deep well pumps and supplies for tube wells manufactured by this company. Includes illustrations and descriptions of vertical deep well pumping engines, power heads, power pump standards, well working barrels and valves, well strainers, etc., etc. Prices of many classes of supplies are included.

Turbines.—Pelton Water Wheel Co., San Francisco. Bulletin relating to Pelton water wheels (impulse turbines) and reaction turbines. Describes the various types of hydraulic equipment manufactured by the company, and discusses their application both to the generation of hydro-electric power and to the direct operation of many different kinds of machinery. Some space is also devoted to governors and to pressure regulating devices.

Railways and Excavation Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 9 South Clinton St., Chicago.

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Managament and Office System

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Sixteen Months' Workings of the Federal Water Power Act

Whatever may be the imperfections of the water power act now standing on the statute books of the United States, the record of the year 1921 indicates quite clearly that it is an improvement over the laws which controlled water power development during the preceding decade. We quote statistics as printed in "Mechanical Engineering" for February.

In the sixteen months following the passage of the Federal Water Power Act of 1920 there were filed with the Commission 185 applications for preliminary permit and 85 applications for license to develop waterpower, aggregating totals of 11,060,000 primary and 5,766,000 secondary horsepower or 16,826,000 horsepower of estimated installation. This is twice the water horsepower which has been developed in the United States to date and [illegible] five to six times greater than the aggregate of all applications filed with the Federal Government during the preceding 15 years.

Up to November 1, final action has been taken on [illegible] applications, in which 27 preliminary permits and 31 licenses were authorized, involving 1,415,600 primary and 2,627,000 installed horsepower. Construction is now under way on the [illegible] licensed projects.

	Primary horsepower.	Installed horsepower.
Henry Ford & Son, Inc., Hudson River, N. Y.	[illegible]	8,100
Niagara Falls Power Co., Niagara River, N. Y.	[illegible]	572,230
Southern California Edison Co., Big Creek, Cal.	[illegible]	546,000
Alabama Power Co., Coosa River, Ala.	[illegible]	110,000
Snow Mountain Power & Water Co., Eel River, Cal.	9,500	16,670
Western States Gas & Electric Co., American River, Cal.	6,400	6,400
Wisconsin-Minnesota Light & Power Co., Chippewa River, Wis. (Preliminary construction only)	10,000	20,000
Total	[illegible]	1,279,400

This record is indeed encouraging, and we may well anticipate that with returning prosperity there will be still further impetus given to power developments. Not only is there proper reason for congratulation on the increase in volume of development, but there is now a maximum of reasonable assurance that the projects to be undertaken are of sound character. We say this advisably, and with full recognition that in the main the water power developments of the past have been wisely undertaken and economically carried out.

Another encouraging feature of the situation is the tendency to join power sources of great areas into comprehensive systems affording the best obtainable load factor and the most economic possible arrangement of reserve and emergency capacity. In the face of the enormously rapid increase in power demand these "super-power" developments may be counted upon to keep the cost of power within reasonable limits, or perhaps even to reduce that cost. It may be that within a score of years the railways of the country will be reaping from the super-power idea a benefit exceeding that of any other class.

The Engineer as a Superior Being

Engineering and Contracting has been a consistent and a persistent advocate of the engineer as the man best qualified to decide many matters and to handle many activities commonly controlled by men from other callings. Likewise, it has been an advocate of "an engineering education" as the best preliminary training for numerous lines of business and industry not usually termed engineering.

From this position we abate nothing, but we do warn against the danger of exalting engineers as superior beings. The engineer is just as human as the carpenter, and the fact that he sometimes deals spectacularly with the forces of Nature does not justify him in treating lightly the work and accomplishments of others. In fact, sad to say, his accomplishments are sometimes spectacular failures.

There are many activities being handled by men of legal or business training which could be handled better by qualified engineers; and the profession is justified in urging that its members be given whatever work they can do better than others; but a too great self conceit in the engineer as in any man is likely to lead to misfortune. We do not imply

that such dangers afflict engineers more often or more severely than they do persons of other callings. In fact, we believe the reverse to be true, but as engineers, it behooves us to note our own shortcomings and to seek their remedy.

Nor does the over-estimation of engineers lie wholly within our own profession. There are outsiders who seem to feel that the mere title of "engineer" is a credential for the undertaking of any task. Engineers and engineering societies should be foremost, not only in disallowing all such claims, but in insisting on the most rigid qualification of all who are placed in charge of important work. We regret that this country has had more than one instance of an engineer justly eminent in some specific line, being chosen and accepting employment in the conduct of work in another field for which he was quite unqualified—sometimes with very unfortunate results.

Elsewhere in this issue we print a short article by Mr. W. J. Towne, Chief Engineer of the Chicago & Northwestern Ry., giving some sound advice—advice likely to be of particular value to the man just out of college—on the subject of the engineer's attitude toward his own abilities and toward his fellow workers from the lowest to the highest. Mr. Towne's article appeared in the February issue of "Professional Engineer," the monthly publication of the American Association of Engineers.

The Failure of the Chicago Shops as a Lesson in Socialism

In our Feb. 1 issue we quoted some details from a newspaper account of the failure of Chicago's municipal shops, which were closed in January, and commented editorially thereon. Comment on the same incident, but with a slightly different emphasis is contained in the recent editorial of the Chicago Tribune which follows in full:

"A committee consisting of aldermen and representatives of several trade unions have been inquiring into the failure of the municipal shops. It diagnoses the case as one of 'mismanagement and politics." Some of the union men want the shops to continue. One of these at least is a Socialist. The case is a lesson in socialism, but no Socialist will learn it. It is a lesson in public operation or bureaucracy. Advocates of public ownership and operation will not learn it. But the public, not committed to any panacea, might give it some attention.

It is easy to see the faults of private ownership and operation faults of human selfishness and defects of human efficiency. But before we assume that we shall better ourselves and escape human limitations by public ownership and operation, it will pay us to observe what happens to experiments in them. Socialism, public operation, means in actual practice, bureaucracy, politics. It means that utilities will be run by politicians and political job holders. Compare a government office with a private utility and do a little thinking. In some cases it may be that the public must take over a utility, but if we are wise we will realize that these are special cases and do not weaken the general rule that private initiative and the pressure of competition produce a higher efficiency and therefore a greater public benefit than the management of politicians produces.

Even where private management produces exorbitant private profits, the wrong is offset in public benefits by efficiency, whereas political management not only maintains a comparatively low level of service but is wasteful and subject to a heavy drain in graft and political upkeep. Economic law corrects exorbitant profit taking where competition is free. In other cases in which monopoly conditions exist or special privileges have been obtained checks can be applied without turning over the industry to the government. There can be neither efficiency nor economy in a management which employs workers on the basis not of their efficiency in the work for which they are paid but for efficiency in political hustling. That is how public operation will be and must be managed and if generally adopted it would put a blight on the prosperity of the country from which rich and poor would suffer.

In Russia they have had a taste of public ownership and management, and it has brought the rich Russian land to the brink of ruin. So Russia is going back to private ownership and management, to private property, and private initiative. In France they have a bureaucracy maintaining a huge burden of public job holders and there is no industrial progress in that country. France's prosperity rests upon the small land holder whose private interest maintains her efficiency and keeps the foundations of French wealth and stability. America is the land of private initiative and any one who is dissatisfied would do well to compare our conditions with those of any bureaucratic or socialistic country in the world."

Book Reviews

Stadia Tables. By Arthur Alvord Stiles, State Reclamation Engineer. 141 pages, 4¾ by 7½ in. Thickness bound ½ in. The State of Texas, Reclamation Department, Austin, Texas. 1921.

This is one of the very best stadia tables which we have ever encountered, its entire substance and make-up being directed to the most convenient and practical use. It gives differences of elevation and horizontal distances for vertical angles for every minute from 0° to 30° and for observed distances as follows: For angles less than 10°, 2.5 unit intervals between observations from 100 to 140, 5.0 unit intervals between observations from 140 to 1,000; for angles greater than 10°, 100 unit intervals from 100 to 900 inclusive. This, of course, requires interpolation for most observations above 10°. For angles less than 10° interpolation is simple and easy when needed, but the completeness of the tables makes such calculations unnecessary except in cases requiring extreme accuracy.

There are tables of correction for focal distances (f + c) for every degree between 1° and 30°, and at the bottom of each page are spaces in which both vertical and horizontal corrections can be listed for whatever instrument may be in use. A cut side index makes it possible to open the book instantly to any page desired. It is printed on thin paper for field use and on heavy paper for office use.

An abridged edition of about one-half the size of the present one is now in preparation. The abridgement will be in the number of distances tabulated. Outside the State offices these books are issued unbound, but the binding can of course be made by any competent binder.

Construction Costs Keeping and Management, by Halbert P. Gillette and Richard T. Dana, published by McGraw-Hill Book Co., New York City, 580 pages, 264 illustrations, 5½x8¼ ins.; $5.

Although its title is slightly changed, this book is virtually a second, but greatly enlarged edition of Cost Keeping and Management Engineering, which was published in 1909. It is difficult to realize that since the appearance of the first edition, only 13 years ago, the entire literature of the science of management has been written, excepting only a few scattering articles. In fact the expression of "science management" was first used in the first edition of this book; but what is far more important, this book contained the first published attempt to create a science of management.

Frederick W. Taylor had written a paper on "Shop Management," but he had expressly stated that his "system of management" was an "invention," and that it consisted of a new combination of three rules of management, none of which in itself was new. There is a vast difference between an invention and a science; and Taylor, having taken the narrow view that his managerial work was based on an "invention," never attempted to produce a code of laws and rules for the guidance of managers. It is true that after the publication of the first edition of this book, which was dedicated to him, Taylor adopted the expression "science of management" and wrote a book entitled "Scientific Management," but he still remained so fettered to his original conception that his book was practically nothing more than a replica of his original paper, on "Shop Management."

In the opening chapter of this second edition, the authors define "science" and "science of management," and they point out that "Scientific Management" has existed from the earliest days of industrial organization. A science of management, however, is of comparatively recent origin." Then follow 14 laws or principles, and 18 rules of management. There is no strict dividing line between a "law" and a "rule" of management, the "rules" being either laws of narrower scope or special injunctions not in the form of a scientific law, but usually susceptible of being thrown into that form.

Of the 220 pages by which this edition exceeds its predecessor, by far the majority relate to cost keeping. One new chapter, for example, relates to highway cost keeping, and contains 40 pages. But it should be noted that much of the matter in this chapter is applicable to other kinds of construction.

The new book is an improvement over the old in typography as well as in contents. It remains a composite of principles of management and of unit cost keeping as a prime aid in scientific management. By giving a great variety of blanks, forms, charts, etc., the book should be of aid to every one in charge of construction. By stating the principles on which unit cost keeping is founded, the book should be even more helpful than through the specific examples of forms, etc.

Few engineers seem to know that unit cost keeping systems are almost entirely the work of engineers, and not of accountants or others. Prof. Hatfield, in his "Modern Accounting," makes a statement substantially in accord with the last sentence.

Low Exchange Rates and Exports

To the Editor: As your paper has made a specialty of economics and as true ideas on public questions will aid in right action being taken, I ask a little of your space to point out that one idea that is current is incorrect, that idea being that a low exchange rate gives the country having it an advantage in international trade, especially in exports.

If that were true Germany would have a great advantage and Poland a still greater one. But that this is not so is proved by the fact that they have lately exported less in proportion than countries having high exchange rate. This can be shown in two ways: by comparing the exports from several countries to one country of steady money value (the United States for example), and by comparing the total exports to all countries from several countries.

By the first method the imports into the United States from various countries has been:

	10 months of 1920.	10 months of 1921.
From Germany	$ 83,000,000	$ 73,000,000
From Poland	700,000	800,000
From France	153,000,000	130,000,000
From Italy	70,000,000	57,000,000

By the second method the total exports have been:

	Annual rate for 1921.
From Germany	$ 810,000,000
From Poland	
From France	1,400,000,000
From Italy	252,000,000

This shows clearly that countries with depreciated currencies do not have an advantage in the export trade, but just the reverse. And this is further shown by the fact that poor old Russia, with the worst depreciated currency of all, has practically ceased to export.

Italy and Poland, though of about equal population, show great inequality in exports to the United States,, as Italy is sending 60 times as much as Poland, though Poland's currency is depreciated nearly 800 to 1, while Italy's is depreciated 5 to 1.

Nashville, Tenn. JOHN WILKES.

A New Blasting Explosive

A new dynamite has just been perfected by the Du Pont Co. The new "powder," known as "Dumorite" is made with a double base of modified nitroglycerin and guncotton. It cannot freeze and does not produce headaches. It is stated to be as powerful, stick for stick, under ordinary conditions, as regular 40 per cent dynamite; in addition, each case contains approximately one-third more sticks. "Dumorite" is a free-running explosive. It is stated to be quick and of great bulk strength. Before it was perfected, several hundred trial mixings were made up, all of which were carefully studied and analyzed by explosive experts. The final explosive was then subjected to every possible laboratory test. It was afterwards taken to the field where it was tried out in actual work under varying conditions as to temperature, rock and kind of work. The results proved the new explosive to be especially adaptable for open work in quarries, construction and agricultural fields, for blasting hard rock and hard ores where the ventilation is good and for use in bituminous coal mines where a permissible is not required and where a large production of lump coal is desired.

Replaceable Drill Bits

Three different attempts are now being made to develop a replaceable drill bit. All are still in an experimental stage, but we believe a practical solution will be obtained in the not distant future. With an efficient replaceable drill bit, a set of standard drill-bit holders made from excellent metal, an alloy that is shock resisting, will form the equipment of each drill, and need be handled only a relatively short distance. The drill bits alone will make the journey to and from the sharpening shop on the surface. As the drill bits represent only a relatively small amount of metal, they can probably be made from a steel alloy which will be comparatively expensive but will be more efficient in drilling capacity. Thus there is the possibility of a considerable economy in drill steel and in handling steel. This is the incentive toward which the experimenters have been working.

Other attempts to make a replaceable drill bit have been made, but with the piston type of drill, used at the time, they were unsuccessful. With the hammer type of drill, the drill steel does not reciprocate, but is held more or less firmly against the bottom of the drill hole. This is a totally different condition from the piston type and it is not improbable that it is more favorable for the use of replaceable bits.

Anaconda has been experimenting with a replaceable bit invented by A. W. Hawkesworth. This bit has undergone a number of changes, and we are told has not yet been fully worked out. A general announcement or "story" appeared in the Anaconda Standard of Nov. 20, 1921, but insufficient details were given to make possible judgment as to its merits. Other experiments which we have known of for some time, are being conducted by the Vanadium Corporation of America and still others are being made by a Western inventor, and we have looked over his work. The subject is of great interest to the mining industries, and the hope is held out that success will reward one or more of the efforts here recorded. As soon as definite results have been obtained in this work, we will inform our readers.—Editorial in Engineering and Mining Journal.

The Trend of Railway Construction

Numerous indications point to the resumption of construction work on a considerable number of roads next spring. Because of this fact it is pertinent to call attention to the gradual but steady transition from the extensive to the intensive development of the railway properties in recent years. This change will be particularly noticeable as work is resumed after the inactivity of the last three years. It is of special importance to the engineering officers of the railways, but hardly less important to those who sell construction equipment and to the contractors who specialize in railway work.

In the early days of American railway development, construction work was almost all of the extensive character—the construction of extensions and new lines. Even as recently as 15 years ago when the St. Paul and the Western Pacific were building to the Pacific Coast and other roads were constructing large mileages of branch lines, the work was principally of this character. This extensive work led to the formation of large contracting organizations which were prepared to handle the entire construction of lines several hundred miles long, including the grading, bridging and the laying of the track itself.

As the traffic has increased it has become necessary to revise the existing lines and to add to the facilities along them. While large areas still await railway facilities in this country, such widespread activity as was seen in 1906 has gone permanently. With the return of railway conditions to normal, branch line construction may be expected to increase materially. However, the great development of the future will be of an intensive character—the amplification of existing facilities. The trend of railway work in this direction is indicated by the following statement issued by the Atchison, Topeka & Santa Fe: "Railroad managements prefer to improve their plants for the efficient handling of the traffic offered, rather than to build new lines at this time to take care of business in various stages of development. A good deal of work will be done in the direction of improving roadbeds and terminal facilities, and possibly some short extensions will be made to round out certain properties, but virgin territory probably will have to wait awhile for transportation facilities."

In the conduct of intensive development work a new problem arises which is not present in the construction of new lines, namely, the necessity for the handling of traffic during the progress of the work. This necessitates a revision of methods. Much improvement work can be done most economically by making use of existing tracks and other facilities and thus potentially at least disturbing regular traffic. The result is that the railways must of necessity exercise much closer supervision over the construction work, and in many cases they are taking it over and performing it with their own forces in order to avoid any division of responsibility. This tendency is increasing and it will bring the railways into the market for more construction equipment such as steam shovels, ditchers, dump cars, spreaders and concrete mixers, as well as a wide variety of auxiliary appliances.—Editorial in the Railway Age.

Cleaning Vertical Pipe Line with Calyx Drill

The following account of the novel application of a Davis Calyx core drill for cleaning a vertical pipe line is reprinted from the Compressed Air Magazine:

In the "Minas de Reunion," Sevilla, Spain, the main pipe line of the turbine pumps got so silted with scale that the pumps had to be closed down and the unwatering of the mine carried on with the auxiliary set. The incrustation reduced the diameter to approximately 3½ in. and the engineers at one time thought they would have to abandon the line altogether, as the cost of taking it out, cleaning and replacing would have been excessive. However, before doing this it was decided by the engineers of the mine to try a Davis Calyx drill and with what results the following figures will show.

The total length of the pipe which is cast iron is 1,100 ft. and the original inside diameter was as follows: 360 ft., 13 in.; 360 ft., 12 9/16 in.; and 380 ft., 12 3/16 in. The flanges are faced with a nipple and recess so that the joints are quite true. Since the pipe was installed owing to a subsidence in the mine the shaft moved somewhat and in the total length of the line there is divergence from the vertical.

In the line there are five expansion joints and from all accounts the cleaning out of these is the most difficult operation.

For the work a special bit was made and the incrustation cut out in one operation but at 500 ft. it was found that the work was too hard on the machine and it is now being done in two cuts. A 4½ in. Davis cutter was run down from the 500 ft. level to the bottom in one operation, that is to say, without removing the rods, opening the hole to about 6 in. and the special cutter was then put through, cleaning the hole out to size. When using the Davis cutter it was necessary to bring the water and silt up to the top, the water being fed through the drill rods in the usual way. When using the special cutter the water was fed outside the rods the silt being run through the center hole and cleaned from the bottom. At the time of writing 700 ft. has been cleaned to a diameter of 11½ in. which will in the future be the standard diameter.

The best results have been obtained running the drill at top speed and an advance of eight feet an hour has been obtained.

As will be imagined the machine is erected in a somewhat restricted space right over the main winding shaft, and the greatest drawback is the limited head room which only allows of a 10 ft. rod being taken out at a time.

The machine used on the job is a standard Davis Calyx drill type "FF" operated by air and after the work is finished will be used for prospecting for coal.

Study to Be Made of Shaft Systems on the Iron Range.—It is proposed by the U. S. Bureau of Mines to make a study of shaft systems on the iron ranges in the Lake Superior mining district. Studies are being made in continuation of an investigation of conditions of subsidence and ground movement in the mines of this district.

The Effort of the American Association of Engineers for the Improvement of the Technical Service of Our Cities

The report of the Committee on Municipal Problems presented at the last annual convention of the association indicates that this organization is making an intelligent effort for the betterment of a condition generally recognized as bad. The report is of such pertinence and practicality that we print it herewith in full.

Municipal technical service is on the average less efficient than other technical organizations to the extent of its failure to attract high-class engineers in sufficient numbers. This means that the distribution of technical ability is unfavorable to the cities. This is not therefore a problem of the engineering profession, but a municipal problem.

The difficulties under which the municipal technical service is laboring have been well summed up by one of the members of the committee as follows: "I believe that the particular disadvantages of municipal public service to the engineering incumbents are the uncertainty of tenure of office, the control of the engineering force by those who are not primarily interested in engineering accomplishment; the unsatisfactory compensation and uncertainty as to advancement in compensation; lack of recognition of the value of adequate technical training; and the willingness of the municipality to accept engineering service of other than a high order. It is much easier to state the troubles than their corrections."

While this may be considered as a phase of the too common ineffectiveness of municipal government, yet it is one in which some improvement may be secured.

There can be no question that this condition of the technical service is primarily due to a lack of understanding on the part of the municipal citizens of the importance of the planning and execution of public works with which technical organizations are charged.

The remedy seems to lie in a better acquaintance of the general public with the character and extent of such work with the possibility of economy under able administration, and of waste and even disaster in the hands of the inexpert or unfit.

The committee feels that the one possible means of improving the situation outlined is through a campaign of education, directed primarily to the general public, and in a lesser degree to public officials and to the technical incumbents themselves.

The committee feels that such education should be through publicity, carried out simultaneously through national and local agencies. Its keynote should be a definite statement that a high class of engineering service is necessary for the public welfare and safety, and for the ultimate economy in the execution of public works.

The committee presents the following specific recommendations:

1. That the American Association of Engineers undertake the educational work outlined above.

2. That the work be undertaken in a spirit of service as a contribution of the profession toward the improvement of public affairs.

3. That there be established in the association an agency to supervise the educational work in connection with municipal technical affairs.

4. That this agency arrange for the writing by qualified engineers of national reputation of popular articles on municipal works such as paving, sewerage and sanitation, water supply, garbage disposal, city lighting, and city planning. That the association secure the publication of these articles to the best advantage.

5. That this agency secure the appointment by each chapter of a representative on municipal affairs who shall arrange for speakers on municipal improvements before civic audiences such as clubs and church associations to the end of familiarizing the public with public works, and who shall arrange for articles in the local press on such matters as may be before the public from time to time.

The Economics of Cross Tie Renewals

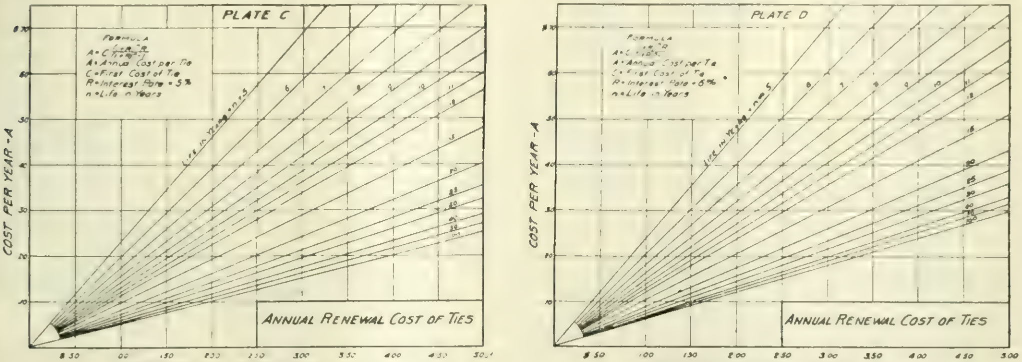
Three Methods of Calculating Annual Cost Discussed in Paper Presented January 25th, at Annual Meeting of American Wood Preservers Association

By V. K. HENDRICKS.

In general there are three methods advocated for calculating cross tie economies, which are, in the order of their simplicity:

a. Without consideration of interest.
b. By the use of simple interest.
c. By the use of compound interest.

In order to adopt the simplest method consistent with reasonably accurate results, we should determine the difference in results by these three methods, which methods are represented respectively by the following formulas:



Plates C and D—Annual Renewal Cost of Ties, Without Allowance for Salvage, at 5% and 6% Interest Rates.

$$\text{(a.)}\quad A = \frac{C}{n}$$

$$\text{(b.)}\quad A = \frac{C}{n} + CR$$

$$\text{(c.)}\quad A = C\frac{(1+R)^n R}{(1+R)^n - 1}$$

In each formula: A = Annual cost per tie.
C = First cost of tie in place.
R = Interest rate.
N = Life of tie in years.

In the paper on "A Method for Finding the Annual Charge for Ties," presented before this association in January, 1915, by Harrington Emerson and T. T. Bower, an allowance is made for a tax rate (assumed at 1 per cent per annum) on the value of the tie, but there is no uniformity as to the method of taxation in the different states, and it is probable the kind of tie used would frequently, if not generally, have no effect on the taxes assessed. For this reason the tax rate has been eliminated from their formula as given above under (b), and it is not included in either of the other two formulas. Formula (c) is the formula adopted by the American Railway Engineering Association, in which the annual charge equals the sum of (1) simple interest on the cost of original installation and (2) the amount, which, at annual compound interest, will provide for renewal at the end of the life of the tie, without allowance for any scrap value of the old ties. In the case of steel ties a scrap value should be provided for, but there is generally no salvage recovered from wood ties.

This formula provides for the annual charge to be made at the end of each year. In order to provide for the payments to be made at the beginning of each year, the formula would be:

$$A = C\frac{(1+R)^n R}{[(1+R)^n - 1](1+R)}$$

This is merely dividing the result by the A. R. E. A. method by one plus the interest rate, and since either formula gives correct relative results and the A. R. E. A. formula is simpler, its use is recommended.

Compound Interest Formula.—There can be no question but that the method (c) of calculating the relative economy of various ties, using compound interest, is the correct method, but the other methods have their advocates, and the claim is sometimes made that a simpler method will give reasonably reliable results.

This compound interest formula (method c) was published by Mr B. E. Fernow, Chief of the Forestry Division, U. S. Department of Agriculture, in Forestry Division, Bulletin Nov. 1, 1890, and the following quotation from that bulletin (p. 34) is of interest:

"We may dismiss at once as improper in a community with well established financial systems, any calculation which does not apply compound interest. There can be a dispute only as to the rate of interest, which in discounting long-standing investments is usually taken at less than the current rate of interest. But, while the choice of the rate is of importance when the actual amount of saving is to be calculated, if the existence only of a saving, no matter of what amount, is to be established, this choice of rate of interest becomes irrelevant, as long as we use the same rate in all cases which we compare. And, especially in the case of two tie systems, the saving which the one of longer duration brings, by virtue of greater safety and permanence of roadbed, is incalculable, so that to establish its superiority financially we need to prove only that it is not more expensive."

Comparison of Results from the Three Formulas.—Based on the three methods given above, the following tabulation shows results for certain ties having a life of 6, 12 and 18 years, and at certain assumed total costs in track:

			Annual cost per tie		
Case No.	Total cost in track.	Average life of ties, years.	No interest (a) cents.	Simple interest (b 6%) cents.	Compound interest (c 6%) cents.
1	$1.20	6	20.0	27.2	24.404
2	2.40	12	20.0	34.4	28.7
3	3.00	18	20.0	41.6	33.3
4	1.90	12	15.8	27.2	22.7
5	2.26	18	13.1	27.2	21.8
6	2.046	12	17.05	29.34	24.404
7	2.64¼	18	14.67	30.52	24.404

These costs in track have been established so that cases 1, 2 and 3 show the same annual cost without considering interest (method a); cases 1, 4 and 5 show the same annual cost using simple interest (method b); and cases 1, 6 and 7 show the same annual cost using compound interest (method c).

It will be noted, not only that the annual cost varies materially by the three methods, but also that in cases 1, 6 and 7, where there is no difference in economy according to the compound interest method c, method a (no interest) shows the higher-cost ties progressively more economical, while method b (simple interest) shows them progressively less economical. Such a result would be wholly misleading, and it is therefore evident that an incorrect method cannot be substituted for a correct one in the interest of simplicity, without risk of failure in some cases, to adopt the tie which is really most economical.

Results in Actual Practice.—Seeing a problem clearly in all its details is a very great aid in its solution, and it may help towards a clear understanding if we follow out the results of these seven cases in actual practice, based on the assumption that each individual tie lasts exactly the average life assumed in each case.

Suppose a road has a total of 1,800,000 ties in track, each one of which lasts just six years, and that exactly one-sixth of them or 300,000 ties, require renewal every year. The annual expenditures would then be as follows:

Year	Case 1 Ties cost $1.20 last 6 Years	Case 2 Ties cost $2.40 last 12 Years	Case 3 Ties cost $3.60 last 18 Years	Case 4 Ties cost [illegible] last 12 Years	Case 5 Ties cost [illegible] last 18 Years	Case 6 Ties cost $2.045 last 12 Years	Case 7 Ties cost $2.64 last 18 Years
1	$360,000	$720,000	$1,080,000	[illegible]	$708,000	$613,500	$792,750
2	360,000	720,000	1,080,000	[illegible]	708,000	613,500	792,750
3	360,000	720,000	1,080,000	[illegible]	708,000	613,500	792,750
4	360,000	720,000	1,080,000	[illegible]	708,000	613,500	792,750
5	360,000	720,000	1,080,000	[illegible]	708,000	613,500	792,750
6	360,000	720,000	1,080,000	[illegible]	708,000	613,500	792,750
7	360,000						
8	360,000						
9	360,000						
10	360,000						
11	360,000						
12	360,000						
13	360,000	720,000		[illegible]		613,500	
14	360,000	720,000		[illegible]		613,500	
15	360,000	720,000		[illegible]		613,500	
16	360,000	720,000		[illegible]		613,500	
17	360,000	720,000		[illegible]		613,500	
18	360,000	720,000		[illegible]		613,500	
19	360,000		1,080,000		708,000		792,750
20	360,000		1,080,000		708,000		792,750
21	360,000		1,080,000		708,000		792,750
22	360,000		1,080,000		708,000		792,750
23	360,000		1,080,000		708,000		792,750
24	360,000		1,080,000		708,000		792,750
25	360,000	720,000		[illegible]		613,500	
26	360,000	720,000		[illegible]		613,500	
27	360,000	720,000		[illegible]		613,500	
28	360,000	720,000		[illegible]		613,500	
29	360,000	720,000		[illegible]		613,500	
30	360,000	720,000		[illegible]		613,500	
31	360,000						
32	360,000						
33	360,000						
34	360,000						
35	360,000						
36	360,000						

This tabulation covers a period of 36 years, as that is the least number of years that will complete a full cycle, and bring all seven cases back to the point where there will again be just 300,000 ties per year to be renewed for six consecutive years, as was the case at the beginning of the cycle.

Relative Economy by Annual Charge and Compound Interest Methods.—If we figure the "present worth" in each case, that is, the amount of money which, set aside at the beginning of the period and placed at annual compound interest (figured at 6 per cent in this discussion), would furnish, at the beginning of each year, the amount required to take care of the renewals for that year as shown in the preceding tabulation for the entire 36-year period, and compare these amounts with the uniform equivalent annual charges derived by multiplying the annual charges per tie (as previously tabulated) by the total number of ties in track (1,800,000), the results are as follows:

Case No.	Annual Charges for the 1,800,000 Ties in Track by Method a	Method b	Method c	Present worth of actual cost of renewals for a 36 year period
1	$360,000	$459,600	$439,272	$5,579,280
2	360,000	619,200	516,600	6,514,604
3	360,000	718,800	593,400	7,600,785
1	360,000	459,600	439,272	5,579,280
4	283,400	459,600	408,000	5,181,145
5	[illegible]	459,600	392,400	4,982,736
1	360,000	459,600	439,272	5,579,280
6	[illegible]	[illegible]	439,272	5,579,274
7	[illegible]	[illegible]	439,272	5,579,187

It will be noted that the relative economy as determined by the annual charge method c agrees in each case with the relative economy shown by the "present worth" column. This comparison is not given as a proof that the compound interest method is correct, for, as a matter of fact, one method of deriving the formula for the compound interest method c for figuring annual charges, is by placing the present worth of the tie renewal charges equal to the present worth of the annual charges, and solving for the annual charge. It is a self-evident fact, however, that

(1) Cases 1, 2 and 3 cannot have the same relative economy as is shown by method a, when it is possible to finance case 1 for a 36-year period for $5,579,280, while it requires $7,600,785 to finance case 3 for the same length of time.

(2) Cases 1, 4 and 5 cannot have the same relative economy as is shown by method b when case 5 can be financed for $4,982,736, as compared with $5,579,280 for case 1, and

(3) Cases 1, 6 and 7, respectively, cannot be progressively more economical as shown by method a or progressively less economical as shown by method b, but all three cases must be of the same economy, as shown by method c, since it requires the same total expenditure to finance each case for a 36-year period.

There can be no question as to the possibility of compounding interest, and unless every dollar is in effect worked at compound interest it is not doing its full duty; likewise, any formula for annual charges which does not apply compound interest is wrong financially, no matter whether it is in connection with maintenance or with construction.

Capitalization of Excess Cost of Tested Ties.—It is unfortunately true that the present accounting rules of the Interstate Commerce Commission do not permit the capitalization of the excess cost of treated ties over untreated ties, and this fact has no doubt had its effect in preventing the use of treated ties to as great an extent as they would be used if the excess cost could be capitalized, as it should be, and as the commission requires in the case of increased weight of rails and other items. A road will naturally hesitate about swelling its maintenance charges for some six or eight or more years before the benefit of the excess expenditure will start to accrue—and more especially so, if there is a possibility that the road may receive no benefit whatever when the economy does accrue through the limit established by the Transportation Act of 1920 to the amount which the road can disburse in dividends. This question of capitalizing the excess cost of treated ties is a question of real importance to the American Wood Preservers' Association, and one which this association might well take up with the Interstate Commerce Commission in order that this industry may be given fair treatment hereafter. However, this is a question of method of accounting, and, while the method of accounting might make it expedient for a railroad to continue the use of a less economical tie in some cases, it would not affect the actual relative economy of the ties; the Government would reap the benefit of the installation of the more economical ties instead of the railroad in such cases.

Excess Cost of More Economical Tie Must Be Figured at Compound Interest.—Neither this accounting method, nor the fact that "interest charges are not properly considered an element of maintenance costs in actual present day accounting," can warrant the no-interest method a of figuring economies, nor do the reasons given in the paper presented to this association in 1915 by Messrs. Emerson and Bower, justify the simple interest method b instead of compound interest. This latter paper states that the irregularities in the life of ties vitiates any compound interest plan. To a certain extent this is true, but when we compare one kind of tie with another to find their relative economy, both kinds of ties will be subject to approximately the same irregularities, if of wood, and any actual error due to this cause will be practically eliminated relatively. The excess cost of a more economical tie over another tie must be figured at compound interest or else the money is not being made full use of, and if the excess cost is compounded, it will give the same result as though the total cost of both ties had been figured at compound interest originally.

In this discussion the costs of ties, life of ties, and interest rates have been assumed arbitrarily merely for the purpose of illustration. In adopting a compound interest rate the following quotation from Mr. B. E. Fernow (who calculated his table of annual charges on a 5 per cent basis) in Forestry Division Bulletin 4, should be borne in mind:

> "If a lower rate of interest is used in calculating the annual charges these, to be sure, fall out lower, but the amounts of saving increase. So that it may be assumed that the table calculated upon a five per cent basis gives the most conservative, practically applicable results."

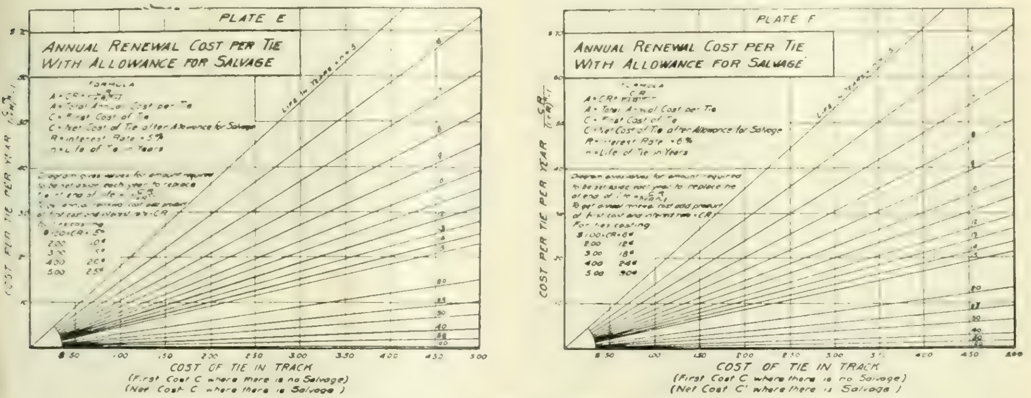
Relative Economy of Various Ties.—In January, 1920, the Committee on Ties, American Railway Engineering Association, made a report on "The Relative Merits of Metal versus Wooden Ties," to the American Railroad Association. Through the courtesy of the American Railway Engineering Association, plates C, D, E and F from that report, are reproduced herewith.

Plates C and D show the annual renewal cost of ties (annual charges) without allowance for any salvage at interest rates of 5 per cent and 6 per cent, respectively (compounded annually).

Plates E and F, at 5 per cent and 6 per cent, respectively, show annual costs allowing for scrap value of the tie

By the use of these diagrams the true relative economy can be determined at once.

The annual renewal costs determined by this method are of value only for determining the relative economy of various ties. A railroad management, however, would require some estimate forecasting its actual annual renewal expenses, in order to determine the feasibility of increasing its tie charges and to make suitable provision for financing the change. A tabulation showing annual expenditures each year, such as is given in this discussion, is probably best and would give an approximate idea of the trend of future expenses, but the irregularity in the life of ties makes it very unreliable for long periods. A closer approximation could be worked out by making use of the data given in the paper by Mabel E. Thorne, published in the 1918 proceedings of this association, showing the "Relation Between Average Life of Ties and Percentage of Renewals." However, this would require a considerable amount of calculation which would hardly be justified by the results obtained for this purpose.



Plates E and F—Annual Renewal Cost of Ties, Allowing for Salvage, With Interest Rates at 5% and 6%.

Factors to Be Considered in Determining First Cost of Tie in Place.—In determining the relative economy of various kinds of ties, all items entering into the costs of the ties in track should be included in the "First cost of tie in place," as follows:

1. Purchase price of ties, f. o. b. cars.
2. Inspection (of ties and treatment) and handling charges, including distribution of ties.
3. Work train charges or estimated cost of transporting over company lines (both to and from the treating plant in the case of treated ties).
4. Freight charges over foreign lines, and switching charges.
5. Interest on the cost of ties during the period they are held for seasoning, providing this is not included in the purchase price.
6. Interest on investment in any real estate, plant, tracks, or other facilities required for procuring, seasoning, or treating the ties, when not included in the purchase price, and also maintenance of such property.
7. Cost of adzing and boring before treatment, and any similar expenses not included in the cost of treatment.
8. Cost of treatment.
9. Cost of the plates. We have no authentic information as to the life of tie plates, but if we assume the life the same as the life of a treated tie, then for a tie having only half that life we should include only half the cost of tie plates, and for other lives in proportion.
10. Cost of spikes. In comparing wooden ties with wooden ties, however, the cost of spikes will be the same and that cost could be omitted without material error; in comparing wooden with metal ties, the spikes must be included to correspond with the metal tie fastenings.
11. Cost of placing ties in track.

The item of "Supervision" has been omitted from this list intentionally, as, aside from the direct charges for inspection (which are included), the supervision is a small item and will be practically the same for all ties in most cases. Only such interest has been included in this list as might be considered as really a part of the cost of the tie, as all subsequent interest is taken care of in the formula for annual charges.

There may be special cases where other items should be included in the original cost in track, or where some modification of the preceding list will be necessary, but this list is believed to meet the requirements in almost all cases.

There would be a scrap value for tie plates in all cases where they are used, but that value would not materialize for a number of years, and at that time the prices for scrap might be materially different from current prices. It would be on the side of conservatism to disregard such scrap value, and not use the tie plates unless their use is justified without it. It would, however, hardly be proper to disregard such a large item as the scrap value on steel ties, but a conservative price for scrap should be used for such ties in order to make sure that the full estimated saving will materialize by their use.

Cost Data on a Quarry Blast

The following detailed cost data was obtained at the blast made at the quarry of the Trumbower Company, Nazareth, Pennsylvania.

The holes were drilled with well drills. Loading started at 9:00 o'clock in the morning and the blast was fired at 4:30 the same afternoon. Hercules low freezing extra dynamite and electric blasting caps connected in parallel were used.

Due to the dip of the rock strata, loading the holes was not easy and considerable care was necessary in getting the explosive to the bottom of the holes.

FIGURES COVERING BLAST AT THE TRUMBOWER COMPANY'S QUARRY

	Distance from Face. Ft.	Distance Between Holes. Ft.	Depth Ft.	Volume of Rock Blasted. Cu. Yd.
Hole No. 1	12	14	50	311
Hole No. 2	12	14	60	373
Hole No. 3	12	14	65	510
Hole No. 4	12	14	65	510
Hole No. 5	12	14	70	558
Hole No. 6	12	14	70	558
Total				2,820 (7,050 tons)

Cost of Powder—		
900 lb. 60% Hercules L. F. "Extra" @ $19.25 =	$173.25	
1,500 lb. 40% Hercules L. F. "Extra" @ 16.75 =	251.25	
600 lb. 30% Hercules L. F. "Extra" @ 15.75 =	94.50	
3,000 lb.		$519.00
Cost of drilling 380 ft. @ $1.25 per foot		475.00
Cost of blasting supplies—		
3—No. 6 40-ft. E. B. Caps	$0.82	
6—No. 6 80-ft. E. B. Caps	3.03	
		3.85
Connecting wire		1.48
Total		$999.33

Estimated tonnage 7,050 tons
Cost per ton $0.1417 (including drilling and blasting)

Ontario Conference on Road Construction.—The 8th annual conference for county road superintendents and engineers of the Province of Ontario, Canada, will be held in the Parliament Buildings, Toronto, Ont., Feb. 27 and 28, under the auspices of the Ontario Department of Public Highways.

Welding Frogs and Crossings with Manganese Steel

Qualities and Methods of Use in Welding Operations Discussed in Paper Read Before American Welding Society, Chicago

By H. R. PENNINGTON,
[illegible]

As actually made, manganese steel contains about 12 per cent of manganese and 1¼ per cent of carbon. The presence of 1½ per cent of manganese makes steel relatively brittle and a further addition at first increases this brittleness, so that steel containing between 5 and 5½ per cent can be pulverized under the hammer. A still further increase, however, gives it great ductility, accompanied by great "tough hardness"—a combination of properties which was not possessed by any other known substance when this remarkable alloy, known as Hadfield's manganese steel, was discovered. It's "tough hardness," to which it owes its value, is profoundly affected by the rate of cooling. Sudden cooling makes the metal extremely hard and ductile; slow cooling makes it brittle. Its behavior in this respect is thus opposite to that of carbon steel. High manganese steel is used extensively for objects which require both hardness and ductility, its remarkable toughness, resistance to shock and abrasive action make it ideal for rock-crushing machinery, railway crossings, mine car wheels, tractor parts, etc. As no process softens manganese steel it must be cut to shape with emery wheels instead of the usual steel cutting tools. It may also be cut with the oxy-acetylene torch.

The extreme brittleness noticeable with steel containing manganese between 4 per cent and 5½ per cent disappears in steel exceeding about 7½ per cent manganese.

A non-magnetic characteristic is noticeable around 8 per cent manganese, and at 12 per cent manganese it is practically non-magnetic. As it is extremely difficult to cold-work manganese steel, manganese wire is drawn only by very special methods.

Manganese steel is a very poor conductor of heat, it having a relative conductivity of only 2.31 (copper 100 per cent), or 75 michrons per cu. centimeter at 15 degrees C. This is about one-seventh the conductivity of iron wire.

Qualities of Manganese Steel.—Chemically the usual cast manganese steel has about the following composition:

	Per cent.
Carbon	1.25
Silicon	0.30
Manganese	12.30
Sulphur, less than	0.02
Phosphorus	0.08

The average of a number of physical tests of cast manganese steel of the above analysis, show the following results:

Tensile lb. per sq. in.	Elastic Limit, lb. per sq. in.	Elongation per cent in 2 in.	Reduction of area per cent
[illegible]	[illegible]	[illegible]	38.56

By the Brinell test, manganese steel toughened or untoughened, shows the moderate average hardness number of about 200. The extreme outer surface of the treated steel shows a slightly lower number—that at a depth of about ¼ in., from which point the number remains constant. The lowering of the hardness number at the surface is due to the oxidation of the carbon during the heat treatment.

The chemical composition and physical properties of the manganese rods and wire used for welding are as follows:

Chemical—	
Manganese	11 to 14 per cent
Carbon	1.00 to 1.30 per cent
Silicon	0.10 to 0.20 per cent
Phosphorus	0.05 to 0.09 per cent
Sulphur	0.01 to 0.03 per cent
Test—Rolled and Forged	
Ultimate tensile strength	[illegible] to 160,000 lbs
Elastic limit	[illegible] to 75,000 lbs.
Elongation	[illegible] to 50 per cent
Shearing strength	100,000 to 110,000 lbs
Cold Drawn Wire—	
Test on ⅛-in. drawn manganese steel wire. Wire not heat treated after last draw	
Ultimate tensile strength per sq. in.	193,000 lb.
Elastic limit per sq. in.	[illegible] lb. (70 per cent)
Elongation	20 per cent in 8-in.
Turns	1
Torsions	15 to 8 in.

The beneficial effect of the cold working incidental to drawing to wire form is very marked, particularly the tensile strength and elastic limit. In the same way it is believed that the metal added by welding to a crossing or frog is improved in the early period of service, due to the constant rolling effect of the passing traffic.

The following test shows the average percentage loss of carbon and manganese for a Wanamaker Coated Electrode No. 9 when fused by the metallic arc process and deposited on a carbon steel rail.

Analysis of wire before welding—	
Carbon	0.99 per cent
Sulphur	0.022 per cent
Phosphorus	0.043 per cent
Manganese	10.51 per cent
Analysis of deposit on rail made from above wire—	
Carbon	0.71 per cent
Sulphur	0.018 per cent
Phosphorus	0.061 per cent
Manganese	10.19 per cent

The following tests were made to show the effect of polarity and the influence of the base metal on the composition of the deposit, the deposit being made on a piece of mild steel ⅝-in. boiler plate.

	Wire Electrode	Electrode Neg. Deposit	Electrode Pos. Deposit
Carbon	[illegible]	[illegible]	[illegible]
Manganese	11.8	8.11	8.1
Phosphorus		0.034	[illegible]

A greater loss of manganese is shown by the deposit on the mild steel plate over that obtained on a carbon steel rail. Concerning the effect of polarity, a greater loss of carbon is shown when using electrode negative than that obtained with the electrode positive. The usual practice is to use an electrode-positive polarity for manganese electrode material.

In the cast state, manganese steel is composed principally of austenite and free cementite, austenite being a solution of iron, manganese and the carbide of iron and manganese, while free cementite is composed of the carbides of iron and manganese which remain undissolved. Free cementite is hard and brittle, therefore manganese steel is also brittle in the untreated cast condition. When, however, it is water toughened, the free cementite is dissolved and the cast manganese becomes austenite, which is ductile. In the process of toughening it is quenched from 1,800 deg. F. in cold water.

Quenching Temperature. The proper temperature from which arc deposited manganese steel should be quenched is a point which has been questioned by some investigators. Some tests have shown a falling off in tensile properties and elongation on quenching from a temperature in excess of 1800° F. The following tests made on ⅝-in. diameter round bars heated to the temperature given for one hour, and quenched in water, tends to confirm this belief. The duration of heating, however, has almost as important an effect as the temperature itself.

Heated one hour at	Elongation, per cent	Breaking strain lbs. per sq. in
1800° F.	56.5	133,400
2100° F.	35.7	93,200

Another test made on the same material by heating test pieces to the temperature shown for only five minutes, shows a considerable less lowering of the tensile and elongation properties, as indicated below:

Heated five minutes at	Elongation per cent	Breaking strain lbs. per sq. in
1800° F.	56.1	142,450
2066° F.	34.1	124,780

In this case, the higher temperature did not effect the elongation and tensile strength nearly as much as when heated at the higher temperature for a period at one hour. The short time at the maximum temperature apparently did not give the steel quite enough time to come fully to equilibrium. In consequence, the structure of the test bars was not greatly altered from that which existed prior to the heat treatment. All test bars when quenched from the heat of rolling showed the following properties, without further heat treatment:

Elongation per cent	Breaking strain lbs. per sq. in
53.3	157,250

In the process of welding, the time period for the heating and cooling cycle is a matter of seconds due to intermittent cooling of parent metal with cold water. For this reason the physical properties of the arc fused metal, although cooled from the melting point 2,462° F. to 2,507° F., would not be injured in any way comparable to that where the metal has been heated for a comparatively long period.

The same lowering of tensile strength and elongation is shown when manganese steel is drawn or quenched from some lower temperature points than the established practice 1,800° F. and when the usual method of heating is employed. In the case of arc welding, however, the metal adjacent to the arc deposited metal cooled from these lower temperatures is not thought to be injured for the same reason as in the case of cooling from extremely high temperatures, i. e., the rapid heating and cooling incidental to arc welding, would not give ample time for normal structural changes to occur.

Welded Manganese Steel Frog Before Grinding.

Metallic Arc Welding of Manganese Steel.—So far as known, the commercial welding of manganese steel up to the present time, was accomplished only by the metallic arc process with coated manganese electrode material and by water toughening the added metal, the metallic arc form of autogenous welding being particularly adapted to the welding of metal of this character, since it is about the only form of autogenous welding which permits, without difficulty, the water toughening treatment of the added metal.

The normal water toughening treatment amounts to raising the temperature of the metal until the desired structure is produced, and fixing it at that point by an increase of the normal cooling rate. Likewise, in the case of welding manganese, the metal heated to a high temperature by the welding operation, is suddenly cooled from a temperature as near equal to that for the desired structure as is possible.

Electrode Material.—The use of a protective coating of the proper character on the electrode material is necessary to prevent vaporization of the manganese and carbon constituents due to combustion, supported by the oxygen of the atmosphere. The function of the coating is to envelope the metal in fusion with a thin slag film, confine the arc gases and exclude to a great extent the atmospheric gases.

The coated manganese steel electrode material is furnished in the following standard sizes:

Diameter.	Length.
⅛-in. drawn	14 in.
5/32-in. drawn	14 in.
3/16-in. rolled	14 in.
¼-in. rolled	14 in.

The size most generally used for track work is 3/16-in. and ¼-in. The 3/16-in. size seems better adapted for general work, especially where 200 square ampere welding units are used.

The approximate arc current and voltage values for manganese electrode material are as follows:

Diameter Electrode.	Approx. Current Arc.	Approx. Voltage Arc.
⅛-in.	100-120	20-25
5/32-in.	150-170	22-28
3/16-in.	175-200	25-30
¼-in.	225-275	25-30

The arc length should be maintained as short as consistent for a uniform flow of metal about 3/16 in. If with this arc length the metal does not flow smoothly, it is likely that the arc current value is too low.

Polarity.—In practice it is found that an electrode-positive polarity gives a better welding characteristic and that the loss of carbon and manganese is less. For this reason, where direct current is used the electrode is made the positive and the work piece the negative.

Arc Manipulation.—When welding with manganese steel on either manganese or high carbon steel, it is found advisable to form a rather wide deposit by a slight oscillation of the electrode, to give a deposit approximately double the width of that obtained by drawing the electrode along a straight line. By this manipulation the deposited metal is kept in a molten condition for a slightly longer period, allowing time for the escape of any gas which may be included in the deposit, and thus preventing the formation of blow holes.

Water Toughening.—To prevent the formation of a brittle structure, the work piece, including the weld area, is kept cool by quenching with cold water immediately after each electrode is used and more often on light sections where the part tends to become too hot, or at any time the welding is interrupted. The result to be accomplished is to keep the work piece cool enough to exercise constantly a quenching action on the deposited metal. Unless the cooling by water is frequent, the rate of cooling will be variable with a corresponding difference in physical character of the added metal.

In track work the cooling is accomplished by directing a small stream of water directly on the previously deposited metal until the heat retained in the part will just dry or vaporize the water. Before the welding is again continued the surface where the arc is to be established must be dry, otherwise difficulty will be experienced in establishing the arc. It is desirable to wipe the surface dry with a piece of waste when necessary before starting the arc.

Welding Procedure.—When building up track parts, such as frogs and crossings, it is advisable to apply each deposit diagonally to the direction of the traffic, and terminate the weld on a bias, the point of the bias being on the flange side of rail, as shown by the accompanying sketch. This procedure is thought to be the best practice, in order to minimize the effect of contraction and possible structural disturbance on the parent metal from the heat of the welding operation.

To avoid roughness or overrunning of the added metal at the flange side of the rail and on both sides of points, a piece of fire brick or carbon block should be set in the flange groove so as to project up and form a wall for the added metal to flow against. The use of fire brick or carbon blocks for making forms at the extreme points and edges will greatly facilitate the welding and result in better and more uniform work.

Where welding is done out in the open, a small shield 8 or 10 in. high should be set up to shield the arc from the eyes of observers and from air drafts, especially on windy days. Unless the arc is protected from air drafts welding will be very difficult, and an unnecessary loss of carbon and manganese will result.

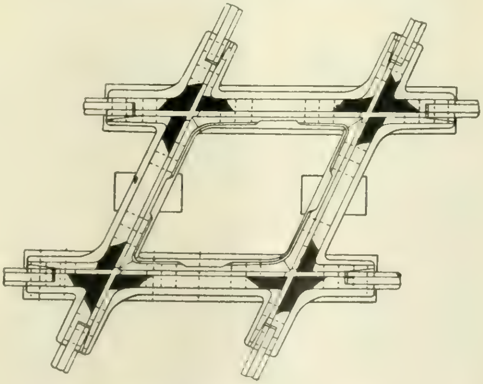


Diagram of Special Crossing Layout.

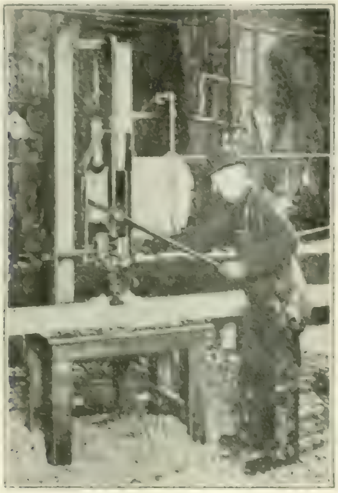
Finishing.—If desired, the weld may be finished by grinding to allow a smooth approach for the wheel and prevent impact at the junction of the weld. However, if pains are taken by the operator to make as smooth a weld as possible, grinding is not considered absolutely necessary. The natural flowing characteristic of manganese steel will in a short [illegible] result in the weld becoming [illegible]. The operator should not only endeavor to make a [illegible] weld but should also use care to see that the top of the weld is level with other parts of the track work, being careful to avoid sharp bumps or low spots.

The records of a number of applications which have been made in both steam railroad and street railway tracks seems to leave little doubt as to the commercial success of arc welding manganese steel. On a service cost basis the service already obtained from welded crossings is such as to insure the permanency of the process.

Mine Timbers Drilled by Portable Air Drill

By rigging up a portable air drill to form a small drill press considerable time and labor was saved at a large Montana mine in drilling mine timbers. The method is described in the January Compressed Air Magazine.

New construction work involved the drilling of about 1,000 4-in. by 9-in. guides for a shaft, each guide having ten holes. The chief mechanic and carpenter boss rigged up a Little David air drill as shown in the illustration, forming a simple but convenient drill press. On this outfit the required holes were drilled at a large saving.



Arrangement of Air Drill for Drilling Mine Timbers

The ten holes were drilled in each guide with a Jennings countersunk bit, the [illegible] in. [illegible] going through 4 in. of wood and the [illegible] in. follower boring [illegible] in. Oregon fir was used generally, although oak timbers were drilled with almost equal ease.

This home made drill press could be used around a great many small mines on similar jobs, the entire outfit being very inexpensive.

High Power Electric Line Placed in Service in Sweden.—The first section of a high-power electric line designed to pass through the center of Sweden from north to south has just been completed and is now in operation. The section connecting the high-power electric station at Trollhaettan Falls, in central Sweden to the city of [illegible], one of Sweden's most important manufacturing centers. It cost about [illegible]. The large waterfalls of north and central Sweden will be utilized to provide power for the great central power line when completed. This is intended to enable Sweden not only to run its trains with electric power but also to electrify the big industrial plants of the country.

French Experimenting with Motors for Branch Railways.—Experiments with internal combustion motors as traction power for branch railroad lines in France have been so successful that they are to be continued on a larger scale, [illegible]

New Cost Plus Contracts

Tentative Drafts of Cost Plus Fee and Cost Plus Fee with Penalty and Bonus Forms

Team-work between contractors, architects, engineers and owners is the object of a new cost-plus contract which has been drafted by the Research Division of the Associated General Contractors under the direction of the Committee on Contracts. This type of contract is not advocated by the Association to the exclusion of lump-sum agreements; but, for the benefit of contractors and owners who do not desire to operate under the latter type, a new form of cost-plus-a-fee agreement has been drawn up. Since the award of a cost plus contract, by reason of the relation which it implies, is based upon confidence in the contractor's skill, integrity and responsibility, no attempt has been made to produce a "legally impregnable" document. The object sought in making the tentative draft was a clean-cut statement of principles which shall permit the contractor to exercise freely his skill and judgment in construction work and yet give the owner quick and easy relief should the contractor fail to fulfill his trust. Before making a final draft of the contract the Committee on Contracts desires to obtain criticism from contractors concerning any question arising from the principles expressed. All changes, omissions or additions suggested will be given careful consideration in revising the agreement. The first tentative draft is reprinted below from The Constructor, the official publication of the Associated General Contractors.

Cost Plus Fixed Fee

THIS AGREEMENT, made the .... day of ...., in the year Nineteen Hundred and .... by and between ....

(Name of firm.)

hereinafter called the CONTRACTOR, and ....

(Name of owner.)

hereinafter called the OWNER.

WITNESSETH, that in consideration of the compensation hereinafter specified, the Contractor and the Owner agree as follows:

1. **Scope of the Work.** This agreement shall provide for the construction and proper completion of ....

(Description of project.)

in full accordance with the existing plans and specifications of ....

(Name of Architect or Engineer.)

and any subsequent plans and written instructions which shall be within the original intent of the existing plans and specifications.

2. **Obligations of the Contractor.** The Contractor shall exercise, for the Owner's benefit, his best knowledge and skill in planning the work, purchasing materials, furnishing labor, supplying equipment and performing all other services incident to the work. He shall cooperate fully with the Owner and the Architect or Engineer and faithfully execute the intent of this agreement.

3. **Obligations of the Owner.**—(a) As full payment for the services rendered by the Contractor in executing the work, the Owner shall pay the Contractor a Service Fee as specified in Article 5.

(b) The Owner shall pay the Cost of the Work as specified in Article 6.

(c) For the use of equipment the Owner shall pay the Contractor an Equipment Rental Charge as specified in Article 7.

(d) For the use of tools, accessories and appurtenances furnished by the Contractor, the Owner shall pay the Contractor a Tool Charge as specified in Article 8.

4. **Status of the Architect or Engineer.** The Architect or Engineer shall prepare all plans and specifications needed to designate properly the quality, quantity and dimensions of the work, except such working drawings as he may direct the Contractor to supply. He shall cooperate fully with the Contractor in executing the work and his decision on the intent of the plans and specifications shall be final. It is his duty to inspect the work and he shall use his offices to see that the Owner shall receive full value for monies ex-

pended and to see that the Contractor shall receive full compensation for his work.

5. **The Service Fee.**—The Service Fee shall be $ and shall include and cover payment for the following:

(a) The Contractor's Profit;

(b) The professional services of the Contractor, his executive officers and members of his firm;

(c) The services of the Contractor's main office employees except when executing drawings, design or preparation of plans required by this contract;

(d) The expense of branch offices not maintained exclusively for this contract;

(e) All general expense of maintaining the Contractor's organization and doing business not directly occasioned by this contract.

6. **Cost of the Work.**—The cost of the work shall include and cover all expenditures made in good faith by the Contractor or the Owner to execute the work of this contract which are not covered by the Service Fee, the Equipment Rental Charge, and the Tool Charge.

7. **The Equipment Rental Charge.**—The Equipment Rental Charge shall include and cover payment for the service of each piece of equipment, except special equipment which the Contractor may use to execute the work, providing said equipment shall be installed upon the work in good operative condition as certified by a competent inspector selected by the Owner.

The amount of the payment for any piece of equipment furnished by the Contractor, except special equipment, shall equal the daily rental rate herein specified for that piece of equipment, multiplied by the number of days elapsing between the date of loading that piece of equipment for transit to the site and the date of reloading it for transit from the site. These dates shall be the dates certified by the bills of lading.

Any special equipment not owned by the Contractor which he may be required to purchase to execute the work shall be paid for by the Owner, and on completion of the work all such special equipment shall be sold and the proceeds thereof credited to the Owner.

Repairs to equipment shall be paid as a Cost of the Work.

(The detailed schedule is intended to be supplied by the individual firm. Since in this contract repairs are charged as a Cost of the Work, they should therefore be omitted in determining the Equipment Rental Charge. Where desirable, the Contractor may pay for repairs and cover them in the fixed rate charges. Attention is called to the Rental Schedule published elsewhere by the Associated General Contractors.)

8. **Tool Charge.**—All tools when brought upon the work shall be listed, inspected and classed according to their condition as follows: New, 100 per cent New; Good, 75 per cent New; Fair, 50 per cent New; Poor, 20 per cent New; Valueless, 0 per cent New.

On completion of the work all tools shall again be listed, inspected and classified as herein stipulated, and the difference between the values as listed first, and as listed second, multiplied by the current market price, shall constitute the tool charge for each tool. Lost or destroyed tools shall be paid for at the first per cent rating multiplied by the current market rate.

9. **Rebates, Revenues, Discounts, Etc.**—The Owner shall receive the full benefit of all rebates and refunds, and he shall receive the full benefit of the discount on all sums paid directly with his capital, if paid in time to secure trade discount.

The Contractor shall deliver to the Owner all revenue derived from commissary, store or other service maintained in connection with the work and all revenue derived from the sale of anything pertaining to the work except those things belonging to the Contractor.

10. **Financing the Work.**—The Owner shall furnish all funds for and shall provide payment for all expenditures incident to the execution of this agreement, except expenditures which the Contractor may make in fulfilling the covenants of the Profit Fee.

11. **Expenditures.**—No expenditure, transaction or subcontract involving more than $...... shall be made in connection with this contract without the approval of the Owner, except that the Owner may authorize the Contractor in writing to make certain expenditures in accordance with the Contractor's judgment, in which case such authority shall constitute the Owner's approval of the expenditure. The Owner shall have the right to make any expenditure directly or to arrange for purchase directly with any dealer.

12. **Payments.**—All payments shall be made by the Owner in accordance with statements issued and certified by the Contractor and approved by the Architect or Engineer, and payments may be made either directly to vendors or indirectly by reimbursing the Contractor.

Payrolls, equipment rentals, team and truck hire and other expenses which the Contractor may find it expedient to pay weekly or oftener shall be paid by the Owner within three days after date of receiving the Contractor's statement including such items. All other indebtedness shall be paid by the Owner within 10 days after receiving the Contractor's statement covering such indebtedness.

On account of the Contractor's Profit Fee, the Owner shall pay the Contractor each month . per cent of the cost of the work for the preceding month. This payment shall be made within ten days after date of receiving the Contractor's certified statement of the cost of the work. When the amount paid the Contractor on account of the Profit Fee shall have equalled 90 per cent of the total Profit Fee no further payment shall be made on this account until the work is completed, at which time the Owner shall pay the Contractor the remaining 10 per cent.

13. **Auditing.**—The Contractor shall keep during the progress of the work and preserve for one year after final settlement, accurate and detailed accounts of all disbursements, and he shall give the Owner access at any and all times to all books, accounts, documents and correspondence of the Contractor which pertain to the execution of this contract.

If the Owner so desires, he shall have the right to place competent employees of his own in any position of accounting, time keeping or checking, provided that such employees shall perform their respective duties in accordance with the Contractor's plans for handling the work, and in co-operation with the Contractor's employees.

14. **Statements.**—Statements of expenses to be paid weekly shall be accompanied by certified copies of payrolls and original invoices covering all expenditures not carried on the payrolls.

Monthly statements shall be accompanied by original bills and invoices and shall be certified by the Contractor.

On or about the fifteenth of each month the Contractor shall submit to the Owner a correct statement of the total expenditures during the preceding month and the total expenditures to date. He shall at the same time furnish the Owner with a progress report of the work.

15. **Sub-Contracts.**—All sub-contracts shall be let by the Contractor (or the Owner) with the approval of the Owner (or the Contractor).

After the award has been made to any sub-contractor, that sub-contractor shall deal directly with the Contractor who shall have full authority over the execution of sub-contracts and shall be responsible for co-ordinating the work of sub-contractors with his general plan of executing the work.

16. **Insurance.**—Insurance against loss and damage to all plants owned by the Contractor shall be carried by the Contractor and cost of that insurance shall be included in and covered by the Equipment Rental Charge. The insurance on Rented Plant and Special Equipment shall be paid for by the Owner as a cost of the work.

All other insurance which the Owner or the Contractor desires to carry shall also be paid for as a Cost of the Work.

17. **Laws, Permits, Licenses.**—The Contractor shall abide by all legal restrictions and obligations of the locality wherein the work is located. In the event that any such legal restriction or obligation should be violated by the Contractor, or any of his employees, the Owner shall be indemnified and held harmless by the Contractor from any legal action resulting from such violation.

The Contractor shall obtain in the name of the Owner all permits and licenses necessary to execute the work, the cost thereof to be paid as a Cost of the Work, and the Owner and the Contractor shall comply with all legal requirements relative thereto.

18. **Liens.**—The Contractor shall indemnify the Owner and hold him harmless from all liens and other incumbrances against the premises on account of debts or claims alleged to be due from the Contractor to any person, including subcontractor, employed by or under him.

19. **Time of Completion.**—The Contractor shall commence

work within .... days after signing this contract and shall complete the work by .... Should the Contractor be delayed in completing the work by any strikes, fire or other circumstances beyond his control, the time of completion shall be extended for such time as will compensate for the time lost by reason of all such acts or circumstances.

20. Owner's Right to Terminate Contract.—The Owner shall have the right after .... days' written notice to terminate the contract if the Contractor's service is unsatisfactory.

In the event that the Owner shall terminate the contract, he shall have the right to take possession of the site and all materials and plant thereon and to complete or employ any person to complete the work, provided that he shall assume all liabilities and obligations which the Contractor has assumed in good faith, and pay the following:

(a) A per cent of the Profit Fee equal to that per cent which the total cost of the work up to the time of termination is of the estimated cost of the work.

(b) The Cost of the Work up to the time of terminating the contract as specified in Article 6.

(c) The Equipment Rental Charge as specified in Article 7

(d) The Tool Charge as specified in Article 8.

21. Contractor's Right to Terminate Contract.—The Contractor shall have the right to terminate the contract after ten days' written notice under the following conditions:

(a) If the work should be stopped by court order or other public authority for a period of more than .... days through no act or fault of the Contractor.

(b) If the Owner should fail to pay the Contractor in accordance with the terms of this contract.

(c) If the Owner should not permit the Contractor to commence work within .... days after signing this contract

In event that the Contractor shall terminate the contract as provided in this article he shall have the right to remove all things from the site which belong to him and return to the renters all things rented by him to prosecute the work; and the Owner shall pay him the sums stipulated in paragraphs a, b, c and d of Aritcle 20, and shall assume all liabilities and obligations which the Contractor has assumed in good faith

22. Title.—The title of all materials for which the Owner is required to pay and for all work either completed or in the course of construction shall be in the Owner. Title of all equipment not purchased by the Owner shall be in the Contractor or in the renter in the case of rented equipment.

23. Assigning the Contract.—Neither party to this contract shall assign the contract or any interest therein, without the written consent of the other party.

The Contractor and Owner for themselves, their successors, executors, administrators and assigns, hereby agree to the full performance of the covenants herein contained.

IN WITNESS THEREOF, they have executed this agreement the day and year first above written.

Cost Plus Fee with Penalty and Bonus

The following clauses should be substituted in the above form if instead of "fixed fee," a "fee with penalty and bonus" contract is desired.

5. The Profit Fee.—In the event that any significant change shall be made in the plans the estimated cost shall be revised according to any change in quantities that may result. This adjusted cost which shall be agreed upon by the owner and the contractor shall be designated as the Revised Estimated Cost and shall be the cost of the work considered in determining the amount of a penalty or bonus.

The Profit Fee shall be $....... , providing the actual cost of the work as specified in Article 6 is within 5 per cent of the Revised Estimated Cost.

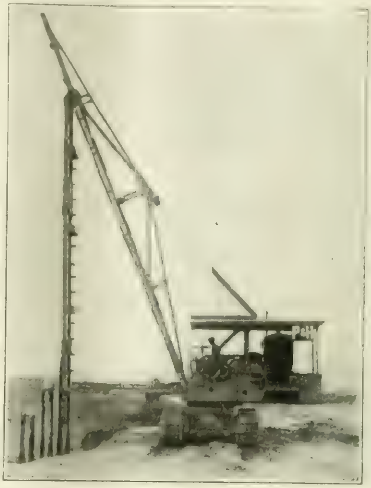
If the actual cost of the work is greater than the Revised Estimated cost by more than 5 per cent the contractor shall credit the owner with ..... per cent of the difference between the two amounts, but in no case shall the contractor pay an amount greater than ..... per cent of the Profit Fee stipulated in this article.

If the actual cost of the work is less than the Revised Estimated Cost by more than 5 per cent the Owner shall pay the contractor in addition to the stipulated Profit Fee ..... per cent of the difference between the two amounts. But in no case shall the owner pay the contractor an additional amount greater than ..... per cent of the Profit Fee stipulated in this article

20. Owner's Right to Terminate Contract.—(a) A per cent of the Profit Fee equal to that per cent which the total cost of the work up to the time of termination is of the revised estimated Cost of the Work.

New Pile-Driving Attachment for P & H Excavator-Cranes

To extend still further the application of P & H excavator cranes, a new pile-driving attachment has been developed by the Pawling & Harnischfeger Co of Milwaukee. This can be used in place of the standard boom, the same as the shovel attachment and road grading skimmer scoop. These P & H machines have been used for pile-driving work before by contractors who rigged up their own pile-driving attachment. The new standardized attachment makes unnecessary this work and makes it possible to change over in shorter time.



Excavator Crane with Pile Driving Attachment.

The construction as shown in the accompanying illustration, consists of two offsetting brackets hinged on the sheave wheel-pin at the head of the boom, with horizontal bracing below. The weight of the hammer is 1,964 lb., and the follower 781 lb. The entire machine can be moved from pile to pile by the same operator, since the attachment is made for use with either the 205 or the 206 full corduroy traction machine.

More Women at Railway Jobs.—The number of women employed by the Class 1 railroads increased from 84,427 in the quarter ended Jan. 1, 1920, to 90,502 in the quarter ended Oct. 1, 1920, according to recent reports from the Interstate Commerce Commission. The wartime experimenal use of women in shop work is being abandoned, but there is an increase in their employment at jobs for which they are better fitted. The number of women employed in shop work decreased 50.9 per cent from 1918 to 1920; women in clerical and semi-clerical jobs increased 18.5 per cent. in the same period.

Civil Service Examinations for Engineers. The U. S. Civil Service Commission, Washington, D. C., has announced open competitive examinations for seven different classes of engineers for the Interstate Commerce Commission for duty in connection with the valuation of railroads and telegraph lines. Salaries range from $1,320 for junior engineers to $2,700 for senior engineers, grade 2. Engineers of the several grades are wanted in the fields of civil, electrical, mechanical, signaling, architectural and telegraph engineering.

Methods and Cost of Thawing Frozen Gravel by Means of Cold Water

A new process for thawing frozen gravel by means of cold water is described by Mr. Edward E. Pearce in a recent issue of the Mining and Scientific Press. The experiments were made by Mr. Pearce in 1918 and 1919 at Candle, 200 miles north of Nome on the Arctic Slope of Seward Peninsula. We quote from his article as follows.

The following is a description of the new process: Fig. 1 shows a general plan of the ground A', A', A' being the portion that had been dredged previously; and B', B', B' the ground desired to be dug. This ground is perpetually frozen. It has no muck on the surface, but there is a layer of muck 2 ft. above bedrock.

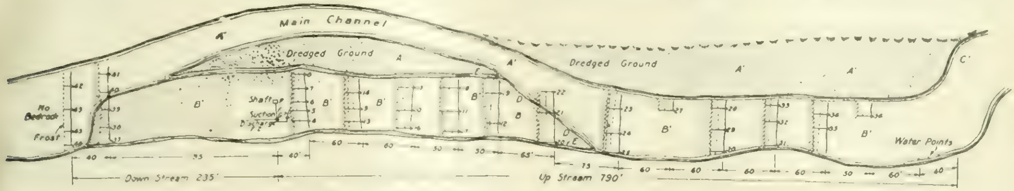
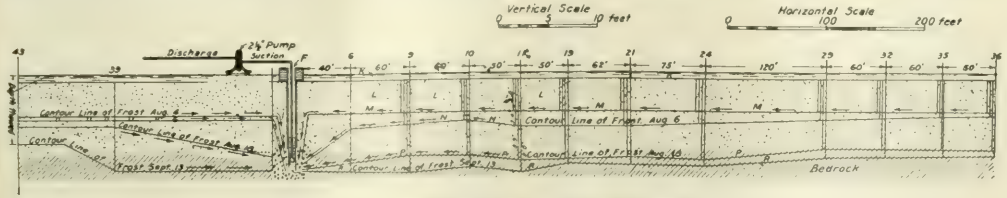


Fig. 1.—Plan Showing the Ground to Be Thawed.

In order to confine our thawing to the area that we intended to dredge, it was necessary to turn the water of the creek C', over the area B' instead of letting it run over A'. Down the stream at D D a bar of gravel rose 2 ft. above the water; and in order to get our seepage to the limits of this bar, which we were to dig, we dug a shallow ditch on each side, as shown at E and E'. Our thawing-area would be then confined within the outside edges of these two ditches. If we had not dug this ditch at E, for instance, all the ground between the shaft F and the side E would have remained frozen, as the seepage to the shaft would all have been from the water side E'. It is therefore important first to block off the area to be dredged, and then see to it that there is surface water at the extreme edges, for no thawing will take place beyond the limits of this surface water.

F is a shaft sunk into the bedrock, F' the suction, and F'' the pump-discharge. G is a 2½-in. rotary pump with a rated discharge of 250 gal. per minute, and H is a 4-hp. Cushman gasoline engine. The numbers 1 to 46 represent test-holes driven at different times to determine the depth that the line of frost has been moved downward. The broken lines are the contours of frost at different dates. The cross-sections along these test-holes are represented as being taken up in place and laid horizontally on the surface of the ground.

Figure 2 is a section taken longitudinally above and below the shaft; it shows the contour lines of frost at different dates, and also the direction of the seepage. A shaft 5 by 5 ft. and 9 ft. deep is sunk at F into the bedrock. It is timbered tightly down to within about 2 ft. of the bottom, and is also extended above any surface water, the whole purpose being to permit no water to enter the shaft except from the bottom. Around the sides and at the bottom some coarse gravel is thrown, to keep the fine from filling in. The shaft will fill immediately with water to the water-level. The suction of the pump is dropped to within about 1 ft. of the bottom of the shaft, and the water from the shaft is exhausted. As fast as this is being done, the creek-water K, seeping through the thawed surface area L, follows along the frost-line M to seek its own level in the shaft F, thus making a continuous flow of fresh water over the surface of the frost. As this operation is continued, so will the frost-line be moved downward until it has reached the level of the bottom of the shaft. The only limits to this system of thawing, up-stream and sideways, are the outer edges of the surface water. It may be advisable, however, in certain instances, to sink two shafts. This can be determined only in each individual case.


Vertical Scale
0
5
10 feet
Horizontal Scale
0
100
200 feet
2½" Pump Suction
Discharge
F
43
39
6
9
10
12
19
21
24
29
32
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36
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120'
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Contour Line of Frost Aug 6
Contour Line of Frost Aug 18
Contour Line of Frost Sept 13
Contour Line of Frost Aug 6
Contour Line of Frost Aug 18
Contour Line of Frost Sept 13
P
P
K
Bedrock

Fig. 2.—Longitudinal Section of Thawed Ground.

In our operations last summer, we found on Aug. 4 (the day we started to pump from the shaft) that the seasonal thaw had reached a depth of 3½ ft., as represented by the contour-line M in Fig. 2. On Aug. 6 the frost-line had been moved downward to contour-line N. On Aug. 18 (the day we stopped pumping) the frost-line had been moved downward through the entire area to be thawed, passing through and thawing a layer of muck, till it had reached and thawed into the bedrock.

The entire area, 790 ft. up-stream and 235 ft. down-stream from the shaft, with an average width of 60 ft., had been completely thawed in a period of 15 days, with an actual pumping-time of 80 hours. This ground was dredged during the same summer and no "horses" of frost were encountered. The ground was thawed well and evenly. The cost per cubic yard to thaw this ground was 1.4 ct. per yard, not including any overhead or equipment charges. In many parts of Alaska frozen muck and sod cover the surface of ground that is rich enough for dredging. Anyone who has mined in the North knows that, when this condition is encountered, the cost of extracting the gold will be increased materially; no matter what method may be employed. In our new process this condition will increase the cost of thawing, but not to such an extent as when thawing by any other method is adopted.

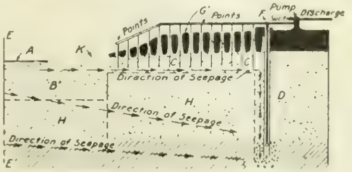

Fig. 3.—Cross Section of Thawed Ground.

Figure 3 represents a cross-section of a piece of ground of this nature, having the creek A on one side, then a bare gravel-bar K, and then a gravel-bar covered with frozen muck and sod G. It is desired to thaw the ground between E E' and the shaft F. We do not want to thaw D; if we did we should move the shaft farther to the right; A is the water in the creek, B' the top gravel of the creek, naturally thawed to a depth of 3½ ft., H H is frozen gravel, and G' G is frozen muck over the surface of the gravel. A shaft is sunk at F into the bedrock. This shaft will remain dry, and no thawing will take place unless a small thawed area C is created below the layers of muck. When this area is thawed a seepage will be maintained from the creek A through the artificially thawed area C into the shaft F. The operations then are the same as they would be were there no muck, as described heretofore. In Fig. 3 cold water points are used to thaw this area. The points are set in the muck to the top of the gravel only, and are spaced 10 ft. apart. It may be contended that as water points are used to start the thawing, they might as well be used to complete the operation. This contention is wrong, for it is an entirely different matter to set points to the top of the gravel and to set them in the gravel to a depth of 15 to 40 ft. Furthermore, there is a tendency in ground of this nature for the frozen collars to extend downward into the gravel, and when thawing with points is completed, there is no certainty that no frost "horses" are left.

TABLE I.—NEW PROCESS OF COLD-WATER THAWING

Equipment Used, Cost of Operations, Area Thawed, and Cost per Cubic Yard Thawed

Equipment.	
One 4-hp. gasoline engine	$135
16 ft. of 1½-in. pipe	40
Tees and ells	10
Foot valve and incidentals	30
Lumber for 5 by 5-ft. shaft, 9 ft. deep	85
Total	$300

Labor.	
Digging shaft, five men for 1½ days	$ 60
Pumping, during digging of shaft, one day, one man	8
Extra man, two days	16
15 days pumping from shaft, one man	120
	$204
Distillate used, 100 gal.	60
Miscellaneous	25
Total	$289

Area thawed, 790 + 235 ft. by 60 × 9 ft. = 20,500 cu. yd. at a cost of 1.4 ct. per yard.

Total time plant was in operation	15 shifts
Total time of pumping shaft	89 hours
Average mean temperature of creek	64° F.
Average mean temperature of discharge	48° F.

TABLE II.—OLD PROCESS OF COLD-WATER POINT THAWING

Equipment Used, Cost of Operations, Area Thawed, and Cost per Cubic Yard Thawed.

Equipment.	
One 50-hp. Union gas-engine	$3,000
One Kingsford pump, 8-in.	500
800 ft. of 12-in. hydraulic pipe	1,000
1,200 ft. of ditch	500
240 ft. of hydraulic hose, 6-in.	240
100 ft. of hydraulic hose, 10-in.	100
4 sets 25 points each	150
800 ft. of 1-in. pipe	80
1,200 ft. of ½-in. pipe	100
700 ft. of rubber hose	400
Tees, ells, unions, valves, etc.	100
Total	$6,170

Labor.	
One point-man, 30 shifts	$ 300
One helper, 30 shifts	240
One engineer, 25 shifts	250
	$ 790
Distillate used, 500 gal.	300
Miscellaneous	50
Total	$1,140

Area thawed, 450 × 80 × 9 ft. = 12,000 cu. yd. or 9½ ct. per yard.

COMPARATIVE STATEMENT OF TABLES I AND II

	Cold-water point method	New process
Cost of equipment used	$6,170	$ 300
Cost of labor	790	204
Cost of oil	300	60
Miscellaneous	50	25
	$7,310	$ 589
Area thawed, cu. yd.	12,000	20,500
Cost per cubic yard thawed	$0.095	$0.014
Average thaw per shift, cu. yd.	400	1,366
Time of plant in operation, days	30	15

New Airplane Compass.—A satisfactory type of airplane compass has been invented by Doctors Paul R. Heyl and Lyman J. Briggs of the Bureau of Standards, of the Department of Commerce. Flying tests with this instrument have been made, and the air service is now engaged in putting a number of models into service. The instrument weighs only 13 lb., while the weight limit set by the air service was 25 lb. The new compass depends for its action not on a magnetic needle but upon a revolving coiled wire. This principle is by no means new, but it has remained for the U. S. Bureau of Standards to apply it in such a way as to make the device practically operative under the very severe conditions prevailing in actual flight or airplane stunts.

Experiences at Indianapolis in Welding Track Joints

Experiences of the Indianapolis Street Ry. Co., Indianapolis, Ind., in reclaiming track by different welding methods were related by Mr. T. H. David, Principal Assistant Engineer, in a paper presented at the annual convention of the Central Electric Railway Association held at Indianapolis, Jan. 26 and 27. An abstract of the paper follows:

Our experience has shown that first-class track in paved streets should not require maintenance for a period of ten years when subjected to a normal amount of traffic of, say, 3-minute headway with city cars or about eight years if hourly interurban service is carried in addition.

The Lorain Electric Weld.—In 1913 we welded 3,000 joints on both old and new tracks, using the Lorain electric weld. This type of joint proved very serviceable and has prolonged the life of track so reconstructed. We have had several instances where the wear on the ball of the rail has decreased its section until it no longer had sufficient stiffness to carry heavy loads and failed by fracture immediately below the ball at the juncture with the web, the joints remaining in fairly good condition.

One case is the track on College Ave. between Massachusetts Ave. and Fall Creek, consisting of Lorain Section 80-335 7-in. high T-rail laid in 1902. This was the first concrete construction, full tied track in the city, and carrying probably the greatest mileage and tonnage of any track outside the loop district. There is no doubt in our minds that the welding done on this in 1913 prolonged the life of the joints and saved the maintenance cost of the pavement which usually gives the first evidence of joint failure.

The paving on this street, excepting at the joints which was naturally repaved with the welding, and excepting 18-in. outside the rails relaid at the time of street reconstruction, is the original paving laid in 1902. Up to a year or so ago the appearance of wear was uniform, that is, the dip and bad pavement at each joint, usually identified with bolted construction, were missing.

Failure of this method of welding usually occurs by ordinary vertical break immediately adjacent to the weld, or the ball of the rail breaks out over the weld. This has been our experience with old rail and we think it partly due to stresses resulting from lack of periodical grinding.

The welds made on new rail up to this time have been very satisfactory and the breakage has been considerably less than 1 per cent. One track containing 250 such welds with about 8-minute city service has had no breaks.

Resistance Arc Welding on Old Track.—From 1914 to about 1918 no welding of new track was done, but considerable resistance arc welding was done on old track of all sections. This method of welding has proved reasonably successful and has only been resorted to in old tracks which we hoped to reconstruct in the near future.

Some 14 miles of 70-lb. track, most of it 20 years old, has been welded since 1912 with the arc welder. Our method has been to cut the base of the angle bar on the gage side and invert the bar on the outside, thus giving the outside of the ball a support. In some cases where tracks were out of surface we have re-tied the joints and a few feet each side, tamping the joint and leaving the quarters suspended for a day or so under traffic.

By this method a considerable amount of the surface bend can be ironed out. Instead of using plain gravel for this work, we used a mixture of cement and gravel in the ratio of about 1:7. In some cases we bonded around a joint of this type in order to insure the proper return. Some of these welds have proved exceptionally good while others failed, the greater percentage failing by the weld breaking loose. It appears that this class of weld can be made to give good results, but the personal equation enters to a greater extent than in some of the other methods of welding.

A piece of track reclaimed by the use of the arc welder consisted of 90-lb. Lorain Section 206 in 30-ft. lengths which was very bad looking before reclamation. The rail was laid in 1894 and on very little ballast, and while small repairs were made in 1910, a complete reclamation was made in 1916 and 1917 with very satisfactory results. Twenty-five per cent of the ties were renewed, mostly at joints, and every joint was welded. In some cases where bolts were loose, the plates were removed and cleaned; and if the bolts were tight, the old plate was welded by adding a ½-in. square rod along the top of the plate to carry the welding strip. Tie plates were put under all joints, these plates being old 9-in. flat joint plates. All cups in the ball of the rail were filled by arc welding and then ground to surface with a rotary grinder.

The track was very smooth riding when completed and the results were gratifying. This track carries 20-ton cars and is a short line wiht a ten-minute service. No bonds were used, and as a rule they are not used in this type of weld except on trunk returns. In all, some 500 joints were welded at a cost of 90 ct. per joint for trackwork, and as the entire street was repaved with brick and stone liners, the paving was $1.50 per square yard. This low cost per square yard is due to the fact that portions of the paving base were not disturbed. The total cost was $15,460 or $2 per lineal foot of single track.

As usual, dry mix was used to bring some joints up to proper surface. This small expenditure per foot has again put this track in condition to last at least eight to ten years with present traffic conditions. Considering the fact that the rail at the time of welding was 22 years old, we cannot expect much more. Up to date we have had only one break, this record being due perhaps to the class of welder we had. In this case credit should be given to the personal factor in obtaining the foregoing results.

Two years ago a double-track electric over single-track steam 90-deg. crossing made of solid manganese broke down at several of the frog points and appeared to be destined for the scrap pile after only six years' service. As a last resort we tried arc welding, using gasoline and a wire brush to clean fractures thoroughly. The points were then built up, soft steel being used and applied in thin layers, each layer being pounded with a hammer while hot to compress the metal. This process was continued until it was built up to the last ⅛ in. and then hard steel of the grade recommended for manganese work was added. This crossing remained in fair condition for some time, but in the two years the points have been rewelded twice by the foregoing method, as the welded portion disintegrated by flaking off.

Experiences with Thermit Welding.—In 1917 we became interested in Thermit welding, but up to 1919 the use of it was limited to combination joints and built-up frogs, the latter being the result of the high prices prevailing for special pieces. If the Thermit method of rail fastening is used, we find that there are three grades of rail that can be welded, with some question as to the wisdom of so doing with the last two: (1) new rail; (2) rail that has been in service for about eight or ten years with moderate traffic, and joints (bolted type) beginning to cup and get loose; and (3) rail of the same age or older that has been subjected to severe traffic.

In the last couple of years we have Thermit-welded two streets of the latter two types to reclaim them, with the hope that our judgment will be vindicated. On Central Ave. from 10th to 19th Sts., approximately 3,700 ft. of double track was reconstructed in 1911, Lorain Section 95-297 being used on white oak ties laid on concrete base. During the last year or so some 40 per cent of the joints showed evidence of pounding and breaking the bond with the immediate pavement. As we did not wish to postpone repairs until rail breakage developed we decided to "Thermit" all joints that showed any evidence of pounding and regrind all of the 280 joints. A total of 114 joints were welded and ten cases of broken rail were found, these breaks occurring along the line of the bolt holes.

The actual welding was done between midnight and morning, the joints being excavated and back-filled during the day on account of the street being narrow and the impossibility to keep automobiles from driving into the excavations. The original joint plates were the 8-hole continuous type, thus leaving about ⅜ in. space between the base of the rail and the tie after welding. Tie plates ⅜ in. x 8 in. x 10 in. were used to give bearing and spot-welded to the base of the rail to hold them in place, as in most cases the ties were cut away to permit the necessary width for the moulds, the original spacing of ties being too close and we did not desire to excavate and respace them. This work of 114 joints was accomplished at a cost of $13.56 per joint for track and $9.84 per joint for paving; total, $23.40 per joint. As these rails were all 62 ft. in length it made the cost per foot of track about 76 cents.

Records show that the number of scheduled cars operating over this track in the ten years was 930,185 or 3,720,740 car wheels on each rail. As the cars all weighed 20 tons, it gives us 18,603,700 tons of weight per track.

This welding was completed in July, 1921, and we have had two breaks since, both of which were rewelded by waxing the joint and pouring additional Thermit.

The track on Massachusetts Ave. between Alabama St. and College Ave. also was welded. This track was constructed in 1910 of Bessemer rail, Lorain Section 91-375, 7 in. high on white oak ties imbedded in concrete or monolithic from subgrade to paving base. This track became so rough at the joints that it was decided to use Thermit in an effort to delay reconstruction at least three years, or for a period that would justify the expense.

The portion of the street used by vehicles was resurfaced in the summer of 1920 and this company relaid 18 in. outside the rails at that time, omitting the grouting at the joints until we could do the welding. Crossovers were placed on the streets and welding was started in October. As this is a trunk line and handles all cars to the northeast section of the city, or about 60 cars per hour during tripper times, our welding was all accomplished between the hours of 9 a. m. and 3 p. m. and 10 p. m. and 5 a. m.; that is, in the off-peak hours.

As the work progressed we found every joint in the entire length of 2,700 ft. of street to be broken. We could not afford to remove the 18-in. strip of pavement only recently laid, so 6 to 10-ft. pieces were put in on the outside rails and welded, while the inside rails were cut and the rails were driven ahead. This method not only eliminated all the bolt holes but the cupped rails as well and also located the new joints on better ties, the old joint ties being cut severely in several cases. Where ties were cut, they were adzed and either steel or wood shims with holes drilled in them for spikes were added to bring to surface.

Before track and paving gangs had completed the work we had eleven breaks due to the new conditions imposed upon the rail in welding. Since then we have had six breaks, four occurring during last winter and two just recently. In each case they were rewaxed and welded. A recent inspection of this track shows it to be holding up in fair shape and it appears that the expenditure made, while large, was justified. On this street, 264 welds were made at the following cost: track, $30 per joint; paving, $15 per joint; total, $45 per joint. As the track rehabilitated consisted of 5,400 ft. of single track, the cost was $2.20 per foot, or a total cost of $11,772.87

Operating statistics show that during the year 1920, 319,263 trips of city cars and 55,773 trips of interurban cars, or a total of 375,036 trips were made over this stretch of track. Therefore, in the past ten years, 15,001,440 wheels passed over each rail. This amount of travel is equivalent to 78,681,030 ton-miles for that interval. These figures, as in the previous estimate, do not include work cars, sweepers, etc., and are based on dead load of cars only.

Siphon Pipes for Catskill Aqueduct

Work is now under way on the construction of two pipes in each of the 14 steel pipe siphons along the line of the Catskill aqueduct of New York City. One pipe is now in place at each of the fourteen points and the three pipes will be capable of carrying the full capacity of the Catskill aqueduct, which is in excess of 500 millions of gallons per day. The new siphon pipes will consist of riveted steel pipes from 7 ft. 4 in. to 11 ft. 3 in. in nominal inside diameter, with plates from 7/16 to 9/16 in. in thickness. They will be lined with Portland cement motrar, enveloped with concrete and covered with an embankment of earth or of earth and rock.

Contracts for these siphons were awerded on Nov. 23 last. Rice & Ganey, Inc., 103 East 125th St., New York City, have the contract for these siphons of an aggregate length of 12,200 ft., the contract price being $999,000. Frederick Snare Corporation, 8 West 40th St., New York City, has the contract for approximately 34,000 lin. ft. of pipe at the seven locations; the estimated amount of this contract is $2,978,103. The thrid contract, which totals $2,275,360, was awarded to the Thomas Crimmins Contracting Co., New York.

The Need for Immediate Resumption of Railway Construction

From a Statement by Herbert Hoover, Secretary of Commerce Before the Interstate Commerce Commission

If we look at the national economic situation as a whole, the greatest impulse that can be given to recovery from any source whatever is a reduction of rates on primary commodities combined with the immediate resumption of railway construction and equipment. The first depends upon reduction of operating costs, the second upon restoration of credit for our railways.

One thing is absolute. Our transportation facilities are below the needs of our country, and unless we have a quick resumption of construction, the whole community—agricultural, commercial, and industrial—will be gasping from a strangulation caused by insufficient transportation the moment that our business activities resume. For the past five years, we have had no consequential expansion to our railway transportation machine. With but one interval of 9 months in 1918 and 1919 we had a car shortage throughout the whole of the years 1916-17-18-19 and 20. This shortage rose to as high as 160,000 cars with a corresponding shortage of motive power. We paid tremendous sums in commercial losses and unemployment in consequence. We laid it onto the war. We should lay it onto our lack of foresight and antagonism to railroads.

Railway Expansion Has Not Kept Up with Growth of Country.—Few people seem to realize the amount of expansion in our transportation machine necessary to keep pace with the growth of the country. And an equal few seem to have any notion of the price we pay for not having it. Our country is more dependent upon railway transport than any other. All others have comparatively greater coast lines and internal waterways. The experience of the twenty years before the war has shown that we must build an extension of lines, including terminal facilities, additional sidings, etc., every year equal to the construction of a new railway from New York to San Francisco. We must add at least 120,000 cars and 2,500 locomotives annually to our equipment. Since we entered the war in 1917 we have constructed at least 10,000 miles of railways less than our increasing population and economic development called for and we are behind in rolling stock by about 4,000 locomotives and 200,000 cars. I wish to emphasize that unless we can have an immediate resumption of construction and equipment, our commercial community will pay treble the cost of the whole of them in their losses of a single season. The very moment that we reach anything like normal business we shall see a repetition of car shortages, followed by an increase in the cost of coal to the consumer from $1 to $3 a ton; we shall again see premiums of 20 ct. a bushel for the use of cars for moving grain; we shall in fact see a shortage of commodities to the consumer; and we shall see gluts upon the hands of the producers. We shall see factories filled with orders again closed for lack of cars; we shall see large intermittency in employment; and we shall see the usual profiteering in commodities due to a stricture between the producer and consumer.

There would be no difficulty whatever, by basing such losses on the experiences we have already had, to calculate a loss to the American people of a billion dollars for each one of these periodic transportation shortages.

Furthermore, there is nothing that is so irrecoverable a loss to the nation as idle shops and idle men. To-day we have both. There is nothing that will so quickly start the springs of business and employment as an immediate resumption of construction and equipment of the railways. When business does resume, we shall need all of our capacity for the production of consumable goods. We shall not only find it strangled for lack of transportation, but we shall find ourselves plunging into the manufacture of this very railway equipment and construction in competition with consumable goods for materials and labor. Herein lies the basic cause of destructive price inflation and booms, with all their waste and over-expansion. In times of depression, we should prepare for the future and by doing so we can cure the depression itself.

Difficulties of Railway Financing.—If we examine the fundamental reasons for failure to resume equipment, we will find them in the loss of confidence in railways as an investment and the competition of tax free securities. We have passed the period of credit strain in this depression. Surplus capital is pouring by hundreds of millions monthly into tax free securities and foreign loans, and yet our railways are unable to finance the most moderate of construction programs. The confidence of the public in railway investments was at so low an ebb before the war that financing by the issue of common and preferred stocks had become impossible and railway expansion was living on bond issues. The confidence of an assurance and continuity in earning power to cover this burden of bonds has been even lowered since the war began, because of the uncertainties of both rising and falling prices, of rising and falling wages, of rising and falling rates preventing all regularity of earnings upon which an investor could be convinced, even if no other difficult factors entered into the problem. I see no occasion to go into the labyrinth of past railway finance, its propriety, or lack of propriety, its foolishness or its skill. That generation is gone by. This Commission approaches the financial problems of the railways upon the actual value, not upon their issues of securities and I take it we are living for the future, not the past. We want transportation, and we want it with the values of private initiative and clean public service.

If we look to the immediate future with its complete necessity of paring the railway earnings down to little more than bond interest, until we give relief to the shipper (and thus the primary foundation to business recovery) I can see little likelihood of convincing the investor as to his margins of safety. There is an atmosphere that our railways will never again earn profits, and that they are not as an industry worthy of investment, and that because private investors will not come to their assistance nobody can do anything.

Far from being impossible for our railways again to return to a profitable footing, I believe it is possible to demonstrate that on an average they will become very profitable. If we assume that the reduction of prices and wage levels will settle at a plane no lower than 50 per cent over pre-war, and if we assume that the present rates are to maintain, and if we assume restored traffic, then the earnings of our railways would exceed 15 per cent on the whole of the Commission's tentative valuation. Surely there is room here for safety to investment, as well as relief to the shipper.

But the circumstances being as they are, confidence being at a low ebb, we do not have the equipment necessary for our business. We are driving headlong for a setback to our whole commerce the very moment that we begin to get on our feet.

Railways Should Propose Program of Betterment.—In these circumstances it seems to me vital that the railways as our greatest industry should propose a courageous program of broad visioned betterments and if necessary the Government should consider giving the use of its superior credit. It would not cost the taxpayer a cent to give the Government guarantee to equipment trusts upon the primary responsibility of the railways the proceeds devoted entirely to improvement and equipment. This is no proposal to take money from the taxpayer. It is a proposal to save him from paying treble the amount of his guarantee in profiteering and losses. It will render a reduction of rates earlier, for unless something is done the improvements will have to be paid over years out of increased rates. Nor would we lose a cent upon the guarantee for if American railways can not earn interest upon their borrowings let us throw up our hands and prepare for a second Russia.

A real program of construction would in its various ramifications give relief to 500,000 or 600,000 of our unemployed. It would enable even added numbers to increase their standard of living, and thus give increased market to the produce of our farmers. Our farmers who look to foreign markets for their surplus should stop to consider that our home consumption of meat decreased nearly 7 pounds per capita in 1921, mostly owing to unemployment and that if this decrease could be overcome it would be worth more than a 35 per cent increase in exports.

We talk glibly of giving billions of credits to foreign countries, to increase our farm exports. I wish to say with all responsibility for the statement, that a billion dollars spent upon American railways will give more employment to our people, more advance to our industry, more assistance to our farmers, than twice that sum expended outside the frontiers of the United States—and there will be greater security for the investor.

Finally, I want to refer to the veritable witches cauldron being fed constantly with hates distilled from the misdeeds of railway promoters in the past, from the conflicts between the railways and the farmers, between the railways and their workmen. From the confusion that arises from it we destroy our railways and destroy ourselves. With this Commission on one hand assuring honesty in finance, justice to the shipper and the railway investor, with the Railway Labor Board assuring justice to workers and, above all, with a great spirit of public service in our generation of railway managers, it is time to call off the witches and take some vision of our national situation if we are to pull ourselves out of this depression.

The Necessity for an Engineer to Be Democratic*

By W. J. TOWNE,

Chief Engineer, Chicago & Northwestern Ry.

I recall when I began railroad work as an engineering assistant. I had a radical viewpoint about engineers. I had seen practical work for a number of years and knew the work-side of it; also, I had the benefit of a technical training and was a little inclined to feel pretty well postedd. I was not looking for anybody to advise me. Later on I began to see that any man who tried to stand by himself and put his knowledge against the field without seeking the co-operation and advice of his fellows, was generally going to be a loser. It is necessary that we have the friendship, at least respect, of our associates, and we must have plenty of that in order to make good our plans and carry them through.

An engineer's training is largely along that line that fits him for a position that is more or less technical and I believe he is inclined to overlook the viewpoint of the fellow that comes up through the operating ranks. He is the man who usually starts in at one job or another and gradually progresses. His original viewpoint is often narrow. He comes along to a position of more importance on the railroad; he is associated with men in the engineering department and unfortunately some of those he meets impress him with an atmosphere of superior beings. As they have the advantage of a technical education, it follows in his mind that they feel themselves to be wiser men and he soon develops ideas of antagonism and a barrier is begun between them.

Superintendents have much praise for engineers and yet, when talking to one of them about putting an engineer in a position of an operating nature, he said an engineer will not do at all. That, of course, is an unfortunate condition for the engineer and perhaps for the company's interest. What we need is a better understanding. If men employed by railways, will show by every performance to the operating men and to their own associates that they are practical, dependable, resourceful, hard working loyal men, with good mental balance, they will find that they are doing the most that anyone can do.

As I see it, one of the essential things is to be democratic, be a mixer; to put it in slang "be a regular guy" with your associates who are performing work along the track, roundhouse, and yards. You will find that these men will warm up to you and give you ideas and make suggestions and really educate you with the things that you little dreamed they had in their minds, and you do not need to ask any questions. All you have to do is to listen; make them feel that you are just a man alongside, no better or worse than they, and that you are trying to get better results. Know them well enough to call them by their first name. Make them feel that you are one of them; then, I believe is when you get the best that they have and you give the best that you have. It is of the utmost importance for men to get along well together.

There was never more chance for advancement than at present. Broaden your experience in every way possible and benefit will follow to your company and to yourself. There is nothing like mixing with others and thus being better understood. One of the troubles today among our people is lack of understanding and lack of sympathy between various classes of endeavor. If you are supervising work of others, undoubtedly, some of you may have to settle differences between management and workers. If you can look at the situation from the other fellow's viewpoint and in a way absorb his troubles, take them onto yourself, you will get satisfactory results; if you can not do these things, there is little hope of getting together with satisfactory results.

An engineering instructor told me, years ago, that a young engineer ought to train himself to answer off hand quickly as to engineering information. He said too many of them are in the habit of withdrawing from any declaration of a fact or any knowledge until they have had a chance to analyze the thing, "figure it out" as they put it. If you want to succeed, he said, with business men, managers and others who are seeking engineering information, you should train yourself in a way to say "it will cost about as much." Do not be afraid to discuss results in a preliminary and reasonable way because ninety times (as he put it) out of a hundred, that is the last you will hear of it. The project may be merely a dream, and if it comes to a realization you will have an opportunity to develop an estimate and rarely will you be put in an embarrassing position by later developments. The big advantage is that you have impressed the man with a knowledge of the subject on which you are supposed to be expert and you have enhanced your own chance; you have increased your value by just that amount. It has rarely failed that a man who could successfully do that, was not in demand. Do not misunderstand me: This can be much abused; if not handled properly, its advantage is destroyed.

In handling cases where men are involved in controversies, if you can not do anything yourself, at least merit the reputation of being fair. Try to have the other fellow feel that you are fair and are trying to go along with him, even though you can not do so.

As you go along be an engineer of railway, hydraulic, sanitary, or other special lines, but be also an engineer of humanity.

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*From "Professional Engineer" of February, 1922.

January Construction 49% Ahead of Last Year

January construction activity was 49 per cent greater in volume than it was in the corresponding month of last year, according to the F. W. Dodge Co. The total amount of contracts awarded last month in the 27 northeastern states of the country was $166,320,000. Although this represented a decline of 16 per cent from the previous month, it was the second largest January total on the Dodge Company's statistical record, having been exceeded only in January, 1920.

Not only did the work actually started in January, as indicated by the awards of contracts, hold up exceedingly well for this season, but the volume of contemplated new work reported, amounting to $435,859,000, was the largest monthly total of contemplated work reported since April, 1921, registering an increase of 3 per cent over the amount reported in December, and 27 per cent over the amount reported in January, 1921. All this indicates an increased volume of construction in 1922.

Residential building accounted for 45 per cent of the January total, amounting to $75,728,000. Business buildings amounted to $23,694,000, or 14 per cent of the total; industrial buildings, $19,695,000, or 12 per cent, public works and utilities, $18,735,000, or 11 per cent. Industrial building, although small, showed a gratifying increase over the previous month.

Drill Steel Troubles in Tonopah District.—Mine operators in the Tonopah, Nevada, district are having considerable trouble with drill steels, as different lots received require different heat treatment in tempering. At one mine the steel does not stand up in hard ground when used in the stopers with the outside water spray. At two different times in one mine the drill bits, after being used five or ten minutes, were noted to be at red heat as drawn from the holes. The problem is being studied by the U. S. Bureau of Mines in the course of its general investigation of drill steels.

Equipment Rental Agreement

Early last year the Committees on Methods and Contracts of Associated General Contractors submitted two tentative drafts of standard agreement forms for rental of equipment. These forms, as well as the comments made upon them by various contractors and association members, were carefully studied by the committee, and from the information thus obtained another draft has been prepared as the 1922 Form of the Associated General Contractors. The agreement is reprinted below from the January issue of The Constructor, the official publication of the Associated General Contractors:

EQUIPMENT RENTAL AGREEMENT—1922 FORM.

AGREEMENT made this .... day of ...., 192...
by and between (Name) ....
(Name) ....
by and between
(Identification) ....
party of the first part, hereinafter called the OWNER and
(Name) ....
(Identification) ....
party of the second part, hereinafter called the LESSEE.

WITNESSETH: That in consideration of the covenants and the payments hereinafter provided, the Owner and the Lessee agree as follows:

Article I. Material Leased.—The Lessee hereby leases from the Owner for use at or near .... all equipment herein named and identified under the List of Equipment, and throughout this agreement designated in whole or in part as "Equipment." Each article of Equipment shall be delivered to the Lessee or his agent in good repair, fully equipped for operation as herein further described, and shall remain in possession of the Lessee, subject to the conditions hereinafter stated, for approximately the time designated in the List of Equipment as the approximate Rental Period.

List of Equipment.

Articles of Equipment	Column No. 1 Identification No.	Column No. 2 Approx. Rental Period	Column No. 3 Rental Rate	Column No. 4 Value of Article

Article II. The Rental Period.— The rental period for any article of equipment shall begin on the day following legal delivery of that article to a public carrier or a carrier of the Lessee, for transit to the Lessee, or if delivered directly by the Lessor on the date of actual delivery to the Lessee, and shall continue up to and including the date upon which such article is either legally delivered to a public carrier for transit from the Lessee's work or is by the Lessee actually delivered to another lessee or to the premises of the Owner. The Rental Period shall be the only time during which the Lessee may become liable for the loss of or damage to the Equipment.

Article III. Payment.—The Lessee shall pay rental for each article of Equipment named in The List of Equipment at the rates thereby indicated for each article.

Payment of rental for each month shall be made by the Lessee on or before the fifteenth of each following month at the Owner's office or such other place as the Owner may designate in writing.

Monthly rental rates shall not be subject to any deductions on account of any non-working time in the month and the amount of rent payable at the beginning or end of the Rental Period for any fraction of a month shall be the monthly rental rate, prorated according to the number of calendar days in such fraction.

Daily rental rates shall not be subject to deductions for any non-working time in the day and shall be paid for each calendar day in the month except that rental on Equipment leased at a daily rate shall not be paid for Sundays and legal holidays unless such Equipment is used on such days.

Daily and monthly rental rates named in the List of Equipment have been based upon the expense of operating equipment ten hours per day, and for each hour over ten during which the Equipment is REGULARLY operated, the daily and monthly rates shall be increased three (3) per cent.

The monthly payment for equipment leased on a unit of work basis shall be the number of units shown in the superintending engineer's estimate multiplied by the rate per unit.

The Lessee shall pay the Owner a minimum rental of 6 per cent of the total value as given in the List of Equipment of any equipment actually delivered to a public carrier or other agency of transit to the Lessee.

Article IV. Transportation.—The Owner shall ship all Equipment f. o. b. public carrier or other agency of transportation as specified by written shipping instructions to be furnished by the Lessee, and shall make shipment on the date named in such instructions, or within five days thereafter.

The Owner shall also at his own expense unload the equipment upon its return from the Lessee's work, but all other expenses of transportation, including handling at the Lessee's shipping point, freight, switching and hauling shall be borne by the Lessee.

Article V. Returning Equipment.—Except in case of cancellation of this agreement this Equipment may be retained by the Lessee until expiration of the approximate Rental Period as designated in Article I, or may at any time, upon ten days' written notice, be returned to the Owner.

After expiration of the approximate Rental Period, which period may be altered by mutual written agreement of Owner and Lessee, the Owner may at any time request release of and the Lessee shall within ten days thereafter release and return the equipment as requested, but any expense incurred thereby over and above that of shipping the Equipment to the Lessee shall be paid by the Owner.

Article VI. Maintenance and Operation.—The Lessee shall not remove, alter, disfigure or cover up any numbering, lettering or insignia painted or otherwise displayed upon the Equipment, and shall see that the Equipment is not subjected to careless or needlessly rough usage; and he shall at his own expense maintain the Equipment in good operative condition, well greased, oiled and repaired and in such condition shall return it to the Owner. All tools, appliances and appurtenances furnished with the Equipment shall be returned therewith in good condition.

(Optional.)

The Owner shall furnish the following operators for equipment subject to the following conditions: ....

Article VII. Damage to Equipment.—The Lessee shall indemnify the Owner against all loss of Equipment and all damage thereto incurred during the Rental Period from fire, theft, flood or any other cause; and the appraisal of any such loss or damage shall be based on the equipment values herein named in Article I. Any public carrier transporting the Equipment to the Lessee during the Rental Period shall be an agent of the Lessee, and any such carrier returning the Equipment to the Owner shall be an agent of the Owner. Short and damage claims of either party shall be made known to the other party within 5 days after receipt of Equipment.

Article VIII. Repairs.—The Lessee shall bear the expense of renewing boiler tubes when the number of tubes renewed in any one boiler during a single calendar month is less than 5 per cent of the total number of tubes in that boiler; but, if the necessary renewals in any calendar month total more than 5 per cent of the total number of tubes in the boiler, the cost of such renewals shall be paid by the owner. The cost of all other repairs, renewals of parts, and the rolling of old boiler tubes shall be paid by the Lessee.

Alternate Paragraph Re Boiler Tubes.—If in order to continue operation it becomes necessary to renew boiler tubes in any equipment, the cost of labor and materials used in making such renewal shall be adjusted between the parties hereto on a basis of fifteen months' life for the new tubes, and the Lessee shall pay one-fifteenth of such cost for each month after such renewal that the equipment is in his possession. The cost of all other repairs, renewals of parts and rolling of old boiler tubes shall be paid by the Lessee.

Article IX. Liability of Lessee.—The Lessee shall indemnify the Owner against all loss, damage, expense and penalty arising from any action on account of personal injury or damage to property occasioned by the operation, handling or transportation of any Equipment during the rental period.

Article X. Inspection.—The Owner shall have the right at any time to enter the premises occupied by the Equipment and shall be given free access thereto for the purpose of inspection, and he shall make an inspection immediately upon return of the Equipment—such inspection to be at the Owner's expense. Any loss or damage to Equipment shall be listed and notice thereof supplied to the Lessee within ten days after receipt of the Equipment or otherwise the Lessee shall be released from any loss or damage claims.

Article XI. Title.—Title to the Equipment shall at all times vest in the Owner unless transferred to the Lessee through sale. The Lessee shall give the Owner immediate notice in case any Equipment is levied upon or from any cause becomes liable to seizure.

Article XII. Termination of Agreement.—Should the Lessee default more than thirty days in any payment, or become bankrupt, fail to maintain and operate or return the Equipment as hereinbefore provided, the Owner shall have the right after three days' notice to terminate this agreement, to take possession of the Equipment, and to recover from the Lessee all rental due, full damages for any injury to, and all expense incurred in returning the Equipment to the Owner's yard.

Should the Owner fail to ship the Equipment as hereinbefore stipulated, this agreement shall, at the option of the Lessee, become void.

Should the equipment, upon receipt by the Lessee, prove not to be in good repair, or good working condition, the Lessee shall within five days so notify the Owner and shall then have the right to make necessary repairs and collect the cost thereof from the Owner; or if the necessary repairs cannot be made within reasonable time and expense as determined by the Lessee, the Lessee shall have the right to cancel the agreement, to return the Equipment at the Owner's expense, and to recover any monies paid to the Owner.

Article XIII. Insurance Premiums.—The Lessee shall pay all premiums for fire, liability and other insurance which he may carry upon the equipment.

Article XIV (Optional). Bond.—The Lessee shall furnish a bond with sureties satisfactory to the Owner to the amount of the total value of the Equipment as stipulated in the List of Equipment, to insure return of the equipment in good condition.

Article XV. Sub-Letting.—No Equipment shall be sub-let by the Lessee, nor shall he assign or transfer any interests in this Agreement without written consent of the Owner. No modifications of this Agreement shall be binding upon either party unless mutually accepted in writing.

Article XVI-A (Optional). Optional—Should the total continuous rental paid to the Owner for any units of the equipment amount to one hundred and fifty per cent. (150%) of the value of such units as stipulated in the List of Equipment, no further rental shall be paid to the Owner and the title of such units shall vest in the Lessee.

The Lessee shall have the right at any time to purchase any part of the equipment by paying the difference between the total continuous rental already paid and one hundred and fifty per centum (150%) of the value given in the List of Equipment, and payment of such difference shall be made upon such terms as the Lessee and the Owner may decide.

Article XVI-B (Optional). Optional Clause.—Should the Lessor agree to sell and should the Lessee agree to buy any article of equipment prior to surrendering possession thereof, the purchase price of any such equipment shall be the value stated in the List of Equipment and...... per cent of the rental paid on such articles shall apply as payment therefor and the remainder be paid as the Lessee and the Owner may agree.

WITNESS the hands of the parties hereto the day and the year first above written all in duplicate.

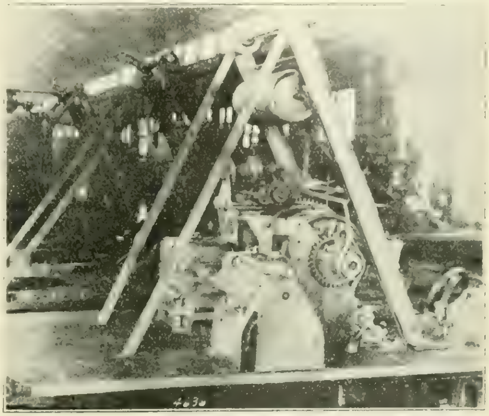
WITNESS ....

WITNESS ....

Santa Fe System to Spend $43,000,000 for Improvements.—The expenditures for repairs and improvements of the Atchison, Topeka and Santa Fe railway in 1922 will be $43,150,000, an increase of $8,150,000 over the amount spent in 1921, according to a statement made public last week by W. B. Storey, president. The principal items for which the money will be spent are the construction of an additional main line track, $6,662,298; a branch line from Satanta, Kas., to a point 55 miles west, $1,400,000; bridges, trestles, and culverts, $1,512,893; stations and office buildings, $1,056,639; rails, $1,101,868; shop buildings, $1,041,350. If conditions were normal, Mr. Storey declared, the road would spend $60,000,000 annually for three years on improvements.

New Types of Small Electric Shovels

The successful operation of electric shovels up to 12 tons capacity having established the practicality of electric drive for this class of machines, the Marion Steam Shovel Co., Marion, O., has recently developed three new types of small revolving electric shovels, with capacities of ¾, 1 and 1½ cu. yd. respectively. They were designed to meet the demand for a small electric shovel for work on street or road construction, in quarries, open mines, lumber reclamation work, and other places where the steam shovel is either impractical or undesirable. The electric generators, motors and control equipment are of the General Electric Co. type. Ordinarily the shovels are equipped with the Marion "crawling traction," but they may be supplied with wide traction, or standard railway wheels instead if desired.



Marion Electric Shovel, Stripped to Show the Interior Arrangement of the Hoist and Swing Motors, Etc.

The new shovels carry their own generating plant, of which there are two varieties, gasoline engine-driven electric, or straight electric. The two smaller types may be equipped with either class of power plant, but the 1½ yd. ones always have the straight electric. The gasoline-electric plant for the smallest shovel consists of a 53 HP. (S.A.E.) 4-cylinder, 4-cycle, heavy duty Matthews gas engine directly connected to a 250-volt, compound wound D.C. generator. That for the larger, or 1-yd. type, is of the same design, but of greater capacity.

Revolving Type Electric Shovel with ¾ Cu. Yd. Bucket.

The electric power plants also vary in horse power for the different capacities of shovels, although the general layout is the same in all cases. They consist of an induction motor of 40, 50 or 75 HP., as the case may be, driving a 250-volt shunt wound generator. The primary current is usually 440 volts, 60 cycle, and is brought to the shovel by means of a specially wound and insulated cable. Since the shovels the revolving a slip ring arrangement is used to transmit the current to the main part of the shovel.

The motor-generator set for straight electric power is interchangeable with the gas-engine generator set on the two smaller types so that it is possible to change any shovel from one type to another if conditions necessitate it. The floor arrangement is the same for each but the bases are specially arranged to accommodate the respective sets, providing an absolutely rigid support for them.

The salient feature in the design of these shovels is the use of separate motors for each motion. With the new, independent drive all the power is applied directly where and when it is needed, and there is no wastage from running idle. The construction as well as the performance characteristics are maintained as nearly as possible to those of the standard steam shovels.

The motors used on the various motions, swing, hoist and crowd are all series wound, mill type, 230-volt D.C., varying in horse power according to the size of the shovel. A motor-driven air compressor which furnishes air for the hoisting clutch and crowding brake is located at the front of the upper frame on the side opposite the control levers. The compressor is started and stopped automatically by means of a pressure governor.

The control equipment in all cases consists of reversible drum controllers with vertical handles and suitable resisters. The latter are of a new and improved type, especially designed to withstand the severe vibration encountered in this class of service. In addition the hoist and crowd circuits are protected by a contactor and a relay which cuts a large block of resistance into the circuit in case a stalling load is encountered.

This protective relay panel is a special feature of the control equipment. It is designed to protect both the motor and the generator from damage when a heavy rock or other obstruction that overloads the motor is met with. Instead of merely breaking the circuit, as is the case with most overload protective devices, it inserts enough resistance in the circuit to limit the current to a safe stalling value. To automatically reset it, and cut the resistance out of the circuit the controller is turned back to the second point.

The three operating handles for the drum controllers are located on the left side of the front end of the shovel, close to the boom, so that the operator has a clear view of the dipper. Each controller has five operating points in each direction, and is designed to work with the minimum amount of effort on the part of the operator. The starting, plugging and protective resisters have been designed for minimum space requirements, but with ample capacity for the most severe working conditions. They are mounted beneath and inside the shovel at the most convenient point compatible with a simple and accessible wiring scheme.

Precautions for Handling Creosoted Pile in Wharf Construction

Suggestions for preventing damage to creosoted piling in handling and in construction in marine structures are given in the second progress report of the San Francisco Bay Marine Piling Committee, presented at the 18th annual meeting of the American Wood Preservers Association, held at Chicago Jan. 24-26. The notes following were taken from the report.

Specifications and Inspections. It should be obvious that specifications and inspections should be co-extensive. The best specification is comparatively valueless unless inspection is both thorough, and of sufficient scope to insure that the specification has been complied with. With respect to piling this should follow through the supply and preparation of the piles, their transfer from source of supply to site, their handling to pile driver, and finally their driving and fastening in the completed structure. The suggestions herein offered are confined to creosoted piling. The committee believes that the best insurance of right results is to have inspection of creosoted piling for final acceptance done as it hangs in the driver gins, where every defect may be seen and examined.

Preparation and Treatment. Creosoted piling should be carefully inspected at the creosoting plant, as to the dimension, form and condition of the piling used, and during treatment especially as to the oils, to see that they are free from adulterants and otherwise fulfill specifications, and as to the penetration of the piling by the oil as required. Creosoted piles should be bored in the course of inspection, in accordance with the tentative specifications presented in this report.

Handling Creosoted Piling.—After having the piling properly treated it is equally important that it be carefully handled from the treating plant to the job. Too much emphasis cannot be placed on the handling and care of creosoted piling. Once the outer protective shell is penetrated the value of the pile is largely destroyed unless the defect is repaired.

Recently a pile-driving crew in this bay had a raft of creosoted piling dogged in the center of the raft. As the raftsman worked the piles out of the raft up to the driver, he drove the dogs into the piles at five different points in their length. It has been a common sight to see rafts of creosoted piling dogged diagonally across, each pile being permanently damaged, as the holes made by the dogs are rarely plugged. The dog is by far the worst enemy of creosoted piling, as is definitely shown, it is believed for the first time, in the service record report of the Board of State Harbor Commissioners which has been presented in this report. Their use should be unconditionally prohibited, except within specified distances of either end which will allow ample margin to protect the water section of the pile. When creosoted piles are prepared for towing considerable distance boring and reeving should be the only method of fastening allowed. The ax, the pike pole and the peavie also cause much damage. The holes left by sinking an ax in the piling, as is frequently done in handling, are much like those caused by the dog, and are particularly dangerous. The use of pike poles and peavies should only be permitted when their points are blunted. The use of boat hooks during inspections by row boat or raft is also a source of considerable damage to treated piles in place and should be prohibited.

Driving Creosoted Piling.—Again it is necessary to take precautions against the puncturing of the protective shell with pike poles, peavies, axes, etc. Unfortunately men handling creosoted lumber and piling do not appreciate the necessity for preserving the protective shell. Eternal vigilance is the price of a good job in this respect.

One of the most important duties of the pile-driving crew is to drive the piles without puncturing the protective shell. There is always danger of checking the piling under the hammer. In using a steam hammer it is well to use piles of a minimum butt diameter of 14 in. This permits the pile to be headed, trimming off all creosoted material so that the plate upon which the plunger strikes rests entirely on untreated wood and is not so likely to cause checking. On rocky bottoms, where there is little or no mud, great care must be taken not to split the pile. This can be done by avoiding hard driving, and by the use of various types of steel shoes and plates.

Cutting Off Piles.—Creosoted piling should not be cut off below high water line, thus exposing untreated wood to attack by borers, if it can be avoided. Even tide slopping, where piling is cut near to high water level, may permit Limnoria attack, if water can settle where it does not run off. Furthermore, decay frequently occurs in the untreated interior of piles when they are cut off at any level above high water. Whenever piles are cut off, therefore, the untreated wood should be protected by thoroughly painting the top of the cut-off portion with hot creosote. Above the water line, a further coating of thick asphalt may be applied, to prevent the penetration of moisture; below water line the access of borers can be prevented by covering tightly with sheet copper.

Bracing, Ribbing, Etc.—The only safe way is to have all bracing, ribbing and other construction attachments well above high water. Where this cannot be done, dapping the piles, which exposes untreated wood, should be prohibited, except where it is absolutely unavoidable, letting necessary cutting or framing be done, so far as possible on the pieces to be attached to the pile, since they are cheaper to renew. The braces, ribbing and other attachment members should be creosoted if they will be exposed to borer attack, and all boring and framing which can possibly be done in advance should be done before the members are creosoted. Otherwise all such holes or framing cuttings should be well swabbed with hot creosote before putting the parts into the construction. All holes for bolts or pins should be bored not larger in diameter than the bolt or pin, to insure a driving fit. This will prevent borers from entering the bolt holes, so far as it is possible to provide against it.

Fender Lines.—Fender lines are always constructed of wooden piling, usually untreated in this region but sometimes treated. Connections to treated piling below the water line, where such connections expose untreated material, are dangerous. Bolt and spike holes provide a ready means for borers to enter. Where it is necessary to bore holes in creosoted fender piling the holes should be bored for a driving fit, as above indicated for bracing.

Repairing Damaged Piles.—When a treated pile is damaged it should be immediately repaired. Holes should be plugged with creosoted material, and where repairs cannot be made in this way the damaged place should be covered with sheet copper. The Board of State Harbor Commissioners have recently been filling such holes, as well as those of the initial attacks of Limnoria working in them, with cement mortar. It is too early to judge the effectiveness of the method, but it looks promising.

Marine Borers and Structures in San Francisco Bay

For the past two years a committee working under the joint co-operation of the Forest Products Laboratory and the American Wood Preservers' Association has been investigating the effect of marine borers on structures in San Francisco Bay. The first progress report of the committee was presented last year at the annual meeting of the associations. An abstract of the report appeared in the March 16, 1921, issue of Engineering and Contracting. At the 1922 meeting of the association Jan. 24-26, a second progress report was submitted. In this later report the conclusions given in the previous one are restated, with modifications which seemed to be required as the result of the year's work. The conclusions follow, all changes of wording from that used in the 1921 report being indicated by italics:

(1) Marine borers are very active in San Francisco Bay and connected waters, and in places where their attack is severe will destroy untreated piling in as short a time as six to eight months. In other places the untreated piling may last from two to four years.

(2) The information secured indicates that it is reasonable to expect a life of five to eight years from paint and batten protections in *sheltered waters,* if the work is well done. If it is not well done, or if the covering is damaged by careless handling *or if unprotected wood is exposed by mud scour,* this range of life cannot be expected.

(3) *The data so far in hand indicate that it is fair to expect creosoted Douglas fir piling in San Francisco Bay to give a life of 15 to 20 years under present conditions. Certain piles are of authentic record from the Oakland Long Wharf which were sound when removed after a service of 29 years. Poor treatment, or damage to creosoted piling by careless handling, rafting, storage or construction, will materially reduce the life which might otherwise be rendered by such piling.*

(4) Most of the attack on creosoted piling by marine borers, which the committee has observed throughout this survey, appears to have begun in spots where untreated wood has been exposed by damage in handling the piles or placing the superstructure. It is urgently recommended that improvements be made in the methods of handling creosoted piles and building structures upon them, so that damage to the surface of the piles may be reduced to a minimum.

(5) Precast reinforced concrete piles and pile casings have not been in use in San Francisco Bay a sufficient length of time to determine their ultimate life. A detailed examination of those structures which have been in service for 10 years shows no evidence of deterioration *below high water line,* and they seem capable of a long further life. The length of life to be expected from this type of construction is largely dependent upon the quality of materials and workmanship and the skill and care with which they are employed; and any laxity in these particulars will materially shorten the length of service which may be secured.

(6) *Reinforced concrete cylinders cast in open caissons have been in use for twelve years. Although the average life of many earlier cylinders has been considerably shortened by construction defects, these cylinders with minor repairs still give promise of a long period of service. Similar cylinders designed and constructed in accordance with best modern concrete practice should constitute a type of construction only excelled for longevity by solid fill or mass concrete.*

(7) Cast in place concrete pile jackets may be expected to give satisfactory results if properly constructed of suitable materials *and proper regard is given toward exclusion of sea water from forms.* The difficulties of this type of construction, however, are of such a nature that the probability of securing a maximum length of life is less than in the case of precast concrete piles or pile casings. (No. 6 in last year's summary.)

(8) *Copper sheathed piles have given very satisfactory service in locations where damage from abrasion and theft can be minimized. Such piles carefully prepared and handled fall into the class of best surface protections, when used under the conditions indicated.*

(9) The selection of a type of piling or pile protection for a given structure must be made upon the basis of cost and permanence of the materials under consideration, the character of the structure and the probable need for future alterations to meet the changing requirements of commerce. When a comparatively short increase over the life of *untreated* wooden piling is sufficient, the surface protections will often be found economical in waters not exposed to severe storm action; if a moderately long physical life approximating the average economic life of marine structures in this harbor is desired, a good creosote treatment will provide it at the lowest annual cost so far as present knowledge goes, if conditions warrant building for the greatest permanence, with less regard for first cost, concrete construction *has shown a high value in this harbor.* For the protection from further damage of wooden piles already in place and showing attack by borers, not yet severe enough to require condemnation, the concrete casing, precast or poured in place, is the only means of salvage so far found by the committee.

Two Largest British Railway Systems Merged.—The two greatest English railroads, the Midland & London and the Northwestern, have been merged. Each has a capital of £205,000,000 (roughly ($871,250,000), and together they own 14,122 miles of track and 8,000 locomotives. The amalgamation is a result of the government grouping of railways for administrative purposes and is simply anticipating making a closer union which would be enforced later. The administration will be concentrated at Euston station, London, and great economies are expected to be brought about.

News Letter

ST. LOUIS ITEMS.

By A. E. Koenig.

Walter Lonergren wants to sublet 25,000 yd. of state road work at Jacksonville, Ill.

Cameron, Joyce & Co. were also awarded 58 miles of state road work in Minnesota

Briggs & Drew Co. have started work on their drag line contract near Carrollton, Mo.

Wm. List took a trip to Honduras the other day to look over his work in that country.

J. L. Moss has 21,000 yd. of slip and fresno work on State Road to sub-let at Keithsville, Mo.

Henry Rees & Sons, Quincy, Ill., secured contract for putting in sewers and pump pit at Bellwood, Ill.

A complete list of Missouri State Highway work to be let is on file at Koenig's Labor Agency, St. Louis.

The L. J. Smith Const. Co. of Kansas City have 3 splendid steam-shovel and standard gauge outfits idle.

J. L. Keller, Route 10, Emporia, Kan., writes us that he desires a job suitable for a 20 team and machine outfit.

Wm. Brothers will finish his levee work at Warsaw, Ill., shortly. Wants to place this outfit on road or levee work.

R. S. L. Construction Co., Marlin, Tex., has just completed 4 bridge and culvert jobs in Texas. Report 3 complete concrete outfits idle that they can place on work immediately.

Bob Morris passed through here on his way from Fairbury, Neb., to Benton, Ill., where he is going to take charge of Tom Higgins' drag line work

Robert Oliver & Co., 4400 Gibson Ave., St. Louis, Mo., have 15,000 yd. of grading on State Road in Rawls County, Missouri, to sub-let.

J. R. Reece of the Capitol Const. Co., Des Moines, Ia., was here trying to scare up a steam-shovel or a grader job for their outfit which is idle in Iowa.

Al Gilliand will finish his road job at Benton, Ill., in a little while. Is looking around for a grading job suitable for a 25 team outfit.

Otto Piffel, 345 Calvert Ave., Webster Grove, Mo., has a 9 team outfit idle that he would like to place on some work in this neighborhood.

Contractors when in want of labor or work for their outfits write Koenig Labor Agency, 612 Walnut St., St. Louis, Mo., or 501 Delaware St., Kansas City, Mo.

Tom Joyce of Cameron, Joyce & Co. spent a few weeks at Hot Springs. Tom returned the other day looking and feeling better than he ever did in his life.

Cameron, Joyce & Co. were awarded 160,000 yd. of grading and 12,000 yd. of concrete and culverts in Alexander County, Ill. Sublet the grading to Lane and Maloney.

Frazier-Davis Const. Co., 1170 Arcade Bldg., St. Louis, Mo., have 27,000 yd. of grading on state road east of Mascouth, Ill. This is short haul and a nice job for about a 10-team outfit.

Mayor Gardner of Little Rock is working on plans for repairing and improving Eighth street viaduct, and that it is his plan to award a contract for necessary work on the structure as soon as practicable.

The contract for completion of a Catholic Orphans Home at Alton, Ill., for the Alton diocese, was let to the Wimmer Const. Co. of St. Louis. There were nine bidders. The successful bid was $311,413.

Up to the present writing contracts for grading and double tracking the Missouri Pacific R. R. between Kirkwood and Pacific, Mo., have not been awarded. Bids were opened on Jan. 3rd and forwarded to New York for approval.

Henry [illegible], 102 N. Van Buren St., [illegible] Ill., [illegible] [illegible] is in the market for [illegible].

W. [illegible] expects to begin [illegible] Warrensburg, Mo. [illegible] [illegible] State Road [illegible] Warrensburg, Mo.

[illegible] Pardyce of Hot Springs, [illegible] of Camp Pike and one of the best known engineers in the South, was appointed by Governor [illegible] a member of the Arkansas Highway Commission, succeeding W. A. Falconer of [illegible], resigned. Col. [illegible] appointment is effective [illegible].

The Wabash Railroad Co. [illegible] the Illinois Commerce Commission to replace with a [illegible] bridge the [illegible] road between [illegible] and Springfield, Ill. In [illegible] Jan. 19th the company is [illegible] to submit plans for the bridge within thirty days and the work is to be completed before Aug. 1st.

The park board of Kansas City, Mo., [illegible] the contract for the [illegible] road between [illegible] and Meyer boulevard to W. C. [illegible] Construction Co. The contract provides for 1,[illegible] sq. yd. of Bitulithic pavement at $[illegible] a square yard and [illegible] of concrete guttering at $[illegible] a square yard. Work will begin as soon as the weather will permit.

The experience of centuries of European road builders will be applied to Missouri **roads by** Theodore Gary, chairman of the Missouri Highway Commission, who will [illegible] for Europe [illegible] pleasure [illegible] will devote most of his time to German and English roads. He intends to examine European roads with the object of making specifications for economic and durable roads for Missouri.

A [illegible] connecting the Arkansas Valley with steam railways at Hutchinson, Kan., and providing entrance into the city for the Missouri Pacific, Orient and Frisco Railways is already under construction. The **Hutchinson Interurban railway is backing the** movement. Howard Caley, general manager of the company, has gone to Chicago to confer with Rock Island officials regarding the matter.

James D. McCarthy of Beardstown was awarded the contract for paving District 10, Beardstown, Ill., when he submitted a proposal amounting to $119,246.18, or 10 per cent below the estimated cost of $[illegible]. District 10 includes Monroe and Lafayette streets and the west end of Main street, a section of Fourth street east of the C. B. & Q. R. R. tracks. Only two bids submitted exceeded the estimated cost.

The Vernon County and Cedar County courts met with the officers of the Kansas City-Springfield Highway Association at the Osage River, eighteen miles northwest of Eldorado Springs, Mo., on Jan. 14, at the site for the new bridge approved by both courts last month. The site was pronounced as being the best [illegible] of any place on the river. The courts jointly ordered that the state highway department make plans immediately for letting **the contract.**

The park board of Kansas City, Mo., awarded the contract to **construct a bridge across Brush Creek, connecting Benton Boulevard** with Swope Parkway, to M. E. Gillioz of Monett, Mo., for $1[illegible]. Work on the bridge will begin within two weeks. The contract provides for a bridge 188 ft. long, 68 ft. wide, to be built with cut stone pylons and hand rail. The specifications require that the work be completed by Jan. 1, next year. A $200,000 bond issue was voted two years ago to pay for the construction of the **bridge.**

Alexander Maitland, president of the Kansas City Bridge Company, now looms as a possible choice of the Democratic bosses for Mayor of Kansas City at the election, April 4. It is understood that Mr. Maitland is considering the matter favorably. In April Mr. Maitland becomes one of the bipartisan water commission to take charge **of the city water works, and will be one of the four** to supervise the new 11 million dollar water plant, if approved by the voters at the next city election. He served last summer as chairman of the ar**bitration board in the building trades wage controversy.**

The Missouri Pacific R. R. has had prepared a new set of plans for the proposed Union passenger station at Texarkana and will **be ready for submission for approval to the Chamber of Commerce** and the Texarkana Freight Bureau within the next two or three weeks. Plans submitted several weeks ago did not fully satisfy the people, hence the new plans. It is said that the new plans contemplate placing the new **station about eight feet farther** north of the site designated in the first plans. According to the plans the new structure will be commodious, modern in all its appointments and will cost between $[illegible] and $300,000.

It is expected that work on a new railroad bridge across the Meramec on the St. Louis **road will be started by the Missouri Pa**cific within the next few weeks. Application for the construction of a new bridge has already received the approval of the War Department and only minor details are holding up a start on the work. Many believe this is a part of the plan of the Missouri Pacific to improve and possibly double track the line between Jefferson City and St. Louis, and it is expected that the bridge to be constructed will be such as to care for the double track. It is also believed that a new bridge will be constructed across the Osage River at Osage City within the next few months, as that bridge has been a place officials of the road have desired to improve.

The State Highway Commission in a regular meeting at Jefferson City, Mo., approved plans on almost [illegible] miles of highway, representing an expenditure of more than $[illegible], according to [illegible] received from the State Highway Department. The [illegible] approved [illegible] state-aid projects [illegible] by the former [illegible] [illegible] of highway and a [illegible] approved for construction [illegible] **6 miles of state**-aid [illegible] a construction cost of $[illegible]. Federal aid projects approved by the board total 136.6[illegible] miles at a cost of $1,388,8[illegible]. The 17 state-aid projects approved [illegible] by the board as well as the 11 state-aid projects approved for construction come under the provisions of the [illegible] road law, which the [illegible] [illegible] to carry out [illegible] under the new road law. The Federal aid [illegible] included in 15 projects.

Personals

A. H. Chambers has resigned as city engineer of Logan, Utah.

Matthew Graham has been appointed superintendent of the municipal [illegible] of Leavenworth, Kan.

Capt. Ralph Rainsford of New York has been appointed chief engineer of the [illegible] Co. and affiliated corporations to succeed F. [illegible], Jr., resigned. He was born in Toronto, Canada, [illegible] and was educated at Harvard University. He [illegible] connected with the [illegible] and later became engineer for the American Smelting & Refining Co. Until recently he was vice president of the W. E. Richards Company of New York.

G. G. Martin of Greenville, Pa., has been appointed supervisor of tracks on the Bessemer & Lake Erie R. R., succeeding P. A. Harris of Grove City, who died recently.

George W. Kable, agricultural agent of Benton County, Oregon, has been transferred to the State Agricultural College at Corvallis, Ore., to head a new line of work as state drainage specialist.

W. F. Renz, heretofore assistant division engineer of the Pennsylvania R. R., at Grand Rapids, Mich., has been appointed supervisor on the Toledo division. H. L. Rogers succeeds him at Grand Rapids.

D. C. Fenstermaker has been appointed principal assistant engineer of the Chicago, Milwaukee & St. Paul Ry. He will be located in Chicago and will handle such matters as may be assigned by the chief engineer.

W. P. Graham, formerly Dean of the L. C. Smith College of Applied Science, Syracuse University, Syracuse, N. Y., has been appointed Acting Vice Chancellor. Louis Mitchell, formerly Professor of Civil Engineering, has been appointed Acting Dean.

R. F. Busher has resigned from his position as chief of the Bureau of Accounts and Statistics of the Public Service Commission of Pennsylvania and has entered the practice of public accounting with offices at Third and Chestnut Sts., Harrisburg, Penn.

Charles Russ Richards, Dean of the College of Engineering and Director of the Experimental Engineering Department of the University of Illinois, has been elected president of Lehigh University. Mr. Richards succeeds Dr. Henry S. Drinker, who retired more than a year ago to become President Emeritus. Mr. Richards is 51 years old and was graduated from Purdue University in 1890. After graduation he became an instructor in mechanical engineering in the Colorado Agricultural College, where he remained until 1911, when he went to the University of Nebraska. Since 1911 he has been connected with the University of Illinois.

Edwin F. Wendt, consulting engineer, has opened an office at Room 513, Union Trust Co. Bldg., Washington, D. C., for the general practice of engineering in connection with valuation, financing, consolidation and regulation of railroads, telegraphs, water lines and other common carrier properties. He was member Engineering Board, Bureau of Valuation, Interstate Commerce Commission, in charge of the Eastern District from May 1, 1913, to Oct. 31, 1921. Mr. Wendt graduated from Geneva College with highest honors in 1888, and was awarded the honorary degree of Doctor of Science in 1913. After graduation he entered the service of the Pittsburgh & Lake Erie R. R. at Pittsburgh, Pa., and was, until he entered government service, engineer in charge, in various capacities, of construction and maintenance work. He was a member of New York Central Lines Engineering Committee, 1907-1913, member of commission to inspect the Government railroad in Alaska in 1917.

Industrial Notes

The Rathbun Jones Engineering Co., Toledo, O., has appointed the Ingersoll-Rand Co., New York, general sales agent for Rathbun **gas engines.**

The Hauck Manufacturing Co., Brooklyn, N. Y., manufacturers of portable oil burners, torches, furnaces, etc., has moved its Philadelphia office to 1726 Sansom St. Herbert Vogelsang, who **has been connected with the Hauck Manufacturing Co. for six years,** will be in charge.

George W. Cravens has been elected president of the Climax Engineering Co., Clinton, Ia., manufacturers of moderate speed, heavy duty engines. G. W. Dulany, Jr., has been elected chairman of the board of directors; C. B. Stebbins has been re-elected vice-president; R. D. Upton re-elected treasurer, and J. M. Thom**sen re-elected secretary. Mr. Cravens, the new president,** was for many years with the General Electric Co., and has had a wide engineering and commercial experience. He has been chief en**gineer for the Elkhart Carriage & Motor Car Co., general manager** of the American Motors Corporation, vice-president and general manager of the Universal Body Co., and is now also a director in several **other companies.**

Westinghouse Electric & Manufacturing Co. announces the following changes and transfers in personnel. Several changes have **recently been made in the Railway Sales Department, the or**ganization of which is now as follows: F. H. Shepard, director of **heavy traction; M. B. Lambert, manager; E. D. Lynch, office man**ager; F. F. Rohrer, assistant to manager in charge of contracts; **C. H. Long, section manager railway equipment contracts and orders; R. Seybold, manager price section; T. H. Stoffel, electric railway freight haulage export; W. R. Stinemetz, manager, and** R. W. Carter, assistant manager of the heavy traction division. K. A. Simmon, manager light traction division; J. L. Crouse, manager, and J. W. Lewis, assistant manager, railway development and supply division. H. A. Campe has been appointed manager of the small motor appliance section of the Industrial Department, succeeding V. M. Beeler, who has been transferred to the Springfield office. H. B. Smith has been appointed manager of the domestic service section of the department, succeeding Mr. Campe. G. L. Washington has been appointed assistant to manager of the **Havana, Cuba, office of the Westinghouse Electric International Company.**

Trade Publications

The following trade publications of interest to engineers and contractors have been issued recently.

Steam Shovels. The Thew Shovel Co., Lorain, O. Bulletin covering Type O steam shovel. Includes diagram and tables showing working range, and illustrations and description of the important features of this shovel.

Steam Shovels.—The Osgood Co., Marion, O. General catalog showing complete Osgood line. Contains tables of information regarding the various types of shovels, working ranges, description and illustrations of particular features, and numerous views of the shovels on construction operations.

Pulverized Coal for Fuel. Hardinge Co., 120 Broadway, New York City. Bulletin on the Quigley fuel systems comprising methods of preparing, transporting and burning of pulverized fuels. A considerable amount of space is devoted to methods of properly preparing and burning the powdered coal.

Centrifugal Pumps.—Worthington Pump & Machinery Corp., 115 Broadway, New York City. Bulletin containing instructions for the installation, operation and maintenance of Worthington horizontal centrifugal volute pumps of the V H type. Contains much useful information, including a curve showing the maximum water temperature allowable for different suction lifts. Other curves are given to show the head capacity and efficiency capacity characteristics of the centrifugal pump.

Building and Structural Monthly Issue

ENGINEERING AND CONTRACTING

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Managament and Office System

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How Local Engineering Societies and Chapters Can Serve the Public

Although it has been frequently urged that engineers either individually or collectively should guide the public on many matters, the reply with equal frequency has been made that engineers seldom have either time or money to devote to public affairs. It must be admitted that this is a serious practical objection to the arguments of those who contend that engineers should assume a leadership that their training and experience warrant them in assuming. However, when the nature of a difficulty is clearly apprehended, means of overcoming it usually can be devised.

Engineers lack time and money for public service. Since engineers' time is purchasable, the fundamental lack is money. Engineers can hardly be expected to contribute all the money needed for investigations and publicity relating to public matters. They can be expected to contribute their share; beyond that the necessary funds must come from others. But who are the others who are likely to respond to such an appeal, and how can they be persuaded to contribute?

In nearly every large city there is at least one organization whose aim is to reduce the waste of public funds. The money that supports these organizations is contributed by public-spirited men of wealth and by far-sighted taxpayers. The fact that such organizations continue to exist, year after year, proves that they are regarded as being worth while, and this in spite of the fact that they are often managed by men whose main ability is as solicitors of money. It seems to us that such organizations could in most instances be better managed by local engineering societies insofar as their economic investigations are concerned. We are not so sure that engineers would prove as efficient in the very important matter of securing the cash contributions needed to carry on the investigations. But what is to prevent engineering societies from employing competent propagandists and solicitors? This might be accomplished in some instances by an affiliation of the existing taxpayers' "league" with the local engineering society. But we doubt whether that could be brought about in many cases, for there is a powerful incentive for the officers of any successful association to resist giving up any of their functions. As a rule, then, local engineers, through their local societies or through the local chapters of national societies, will probably find it necessary to organize a new department whose function it will be to investigate many economic problems and report to the public.

We would not restrict the scope of the investigations to purely engineering problems, although those would probably take precedence over others. Engineers are the only large class of scientifically trained men whose training and experience fits them to solve economic problems. Many business men are expert economists, but lacking a scientific training their tendency is not to impart many of their methods to others, but rather to use all their knowledge for their personal gain and that of their associates. Scientific men, on the other hand, tend not only to publish all their methods but to devote their services very largely to social progress even at the expense of their personal income. For this reason, and because their numbers and influence are so great, it seems to us that all engineers should become very active in political economics. This activity should not be confined to discussing economic problems, but should include such activities as are now monopolized by municipal and taxpayers' "leagues" and the like. Therefore, we commend to every engineering society, and particularly to local societies and to local chapters of national societies, a study of ways and means of launching a campaign for securing funds with which to make local investigations of economic problems and to convey the results to the public.

Whose Duty Is it to Insist Upon a Quantity Survey?

We are glad to note that engineers, architects and contractors have at last gone on record in favor of the making of quantity surveys of buildings at the owner's expense. It has long been the custom of civil engineers to prepare quantity surveys, commonly known as "bidding sheets," for construction work other than buildings. In fact nearly every class of civil engineering structure, except buildings, is quantified by the engineer prior to submitting it to contractors. How does it happen, then, that buildings have hitherto been an exception to this rule? We think the reason is to be found in the fact that supervising architects are commonly paid for their services on a percentage fees and not on a salary basis. It is but natural, therefore, that an architect should shift onto the contractor's shoulders the expense burden of preparing the data for estimating the cost of construction. If only one contractor were invited to bid on each building, there would be no economic loss from this practice, but ordinarily several contractors submit bids, and in doing so each one duplicates the quantity survey work of the other.

Now that the American Institute of Architects has indorsed the plan to have the building owner pay for a quantity survey, we suggest that the architects increase the percentage charged for their services to provide for the cost of making a quantity survey, and they do not leave such a survey optional with the owner. The omission of a survey is conceded to be an economic mistake. If so, why countenance it any longer? In our Jan. 25 issue we reprinted an editorial from the Journal of the American Institute of Architects favoring the quantity survey and payment for it by the owner. The last sentence of that editorial reads: "Any man proposing to spend a considerable sum of money in building should insist on a quantity survey, as one of the most certain means of economy that he can display." True, but will the average owner insist upon a quantity survey? We doubt it, because the average owner knows very little about building economics. If so, the insistence should come from the men whose specialty it is to study building economics, namely, architects and engineers. They should carry their insistence to the point of refusing to take charge of building construction unless such a survey is made part of their work.

The Possibility of Defeating Disease by Chemical Research

Only by a massive co-ordinated attack of many workers can we hope to save time and all it means to us." This quotation is from a report by nine scientists on the need for intensive chemical research to relieve human suffering and prolong life. It is significant to note in passing that this report is the outgrowth of an editorial written by a chemical engineer and published three years ago in the Journal of Industrial and Engineering Chemistry.

After outlining some of the remarkable achievements effected by chemico-biological research, the report urges the supreme importance of a "massive co-ordinated attack of many workers." It is made clear that the pitifully slow progress in mastering disease is not attributable to poor strategy or bad tactics, but to the numerical weakness of the attacking army. The cry goes up from men who know what can be done, and speedily done, if enough trained scientists are enlisted in the army to wage war against pneumonia, tuberculosis, cancer and all that host of, as yet, unconquered enemies of man.

The authors of this remarkable report—we would prefer to call it a cry for help rather than a report—direct our attention to the discovery of several recent chemical cures and preventives, such as salvarsan for syphilis, chaulmoogra oil for leprosy, thymol and chenopodium for hookworm, luminal for epilepsy, thyeoxin for stunted growth of mind and body, vitamines for beri-beri and scurvy, and sodiumioxide for goiter.

These are but examples of victories won against disease by the aid of chemists. They are sufficient to warrant every scientific man in supporting the appeal of the nine authors of this report. Indeed, should not the 100,000 engineers of America, through their national societies, take the lead in awakening the country to what can be accomplished by the employment of a host of chemists, biologists and research physicians? If men trained in applied science do not appreciate what marvels scientific research can accomplish, who will appreciate it? If with appreciation of the possibilities engineers remain inactive we shall be deeply disappointed.

An Important Bulletin on Price Indexes

The use of price indexes, or index numbers of commodity prices, is becoming more and more common. Wage controversies, hearings on public utility rates, questions as to the wisdom of constructing at present prices, and many other economic problems involve price and wage levels. Consequently there is a growing call for just such literature as that contained in Bulletin No. 284 of the U. S. Bureau of Labor Statistics, entitled "Index Numbers of Wholesale Prices in the United States and Foreign Countries."

This bulletin contains 350 pages, of which nearly 100 pages are devoted to methods used in making index numbers. Then follow 20 pages of critical comparison of the leading American index numbers for the years 1890 to 1918. The index of the Federal Reserve Board is given and briefly described, but is not critically discussed.

Price indexes are being misused by many people who have only a smattering of knowledge of price levels. Hence every engineer and contractor who has occasion ever to quote price level data should secure a copy of this bulletin and study it.

A Civic Bureau Twice Headed by an Engineer

Apropos of our leading editorial in this issue, we note that the San Francisco Bureau of Governmental Research, "an incorporated non-partisan citizens' agency to study public business, co-operate with officials and specifically work for economy and efficiency in municipal affairs," has had an engineer as its executive head since January, 1918. Mr. Paul Eliel occupied this position, with the title of "Director" from the date named until the latter part of 1921, when he resigned to engage in private industrial engineering work. Upon the acceptance of Mr. Eliel's resignation as Director, he was elected a member of the Board of Trustees. The successor to the position of Director is Mr. William H. Nanry, an original staff member of the Bureau, having joined it is "Engineering Examiner" in 1917.

It is a pleasure to find such an organization so headed, and we hope from time to time to be able to report other instances of such leadership by engineers. We also observe among the trustees of the San Francisco organization, a chemist of international note, and a professor of economics and accounting, who is known as the author of one of the most practical of the extant books on these subjects.

Apportionment of Labor Cost in Building Small Houses

The Division of Buildings and Housing of the U. S. Bureau of Standards has recently completed a table showing the relation which the amount paid to each labor group bears to the total labor cost in the construction of a 6-room house. The table covers both frame and brick houses and is as follows:

TOTAL LABOR COST (100% BASIS).

Trade	Frame house	Brick house
Carpenters	49.6	32.2
Bricklayers	6.2	21.5
Hod carriers	2.2	6.7
Plasterers	7.9	8.8
Plumbers	8.7	7.6
Electricians	2.6	2.5
Painters	10.0	6.8
Common laborers	6.3	9.9
All others	6.5	4.5
Total	100.0	100.0

These averages were constructed from reports covering a large number of 6-room brick and frame houses throughout the country.

The relation of the amount paid to the various groups to the total labor costs varies according to the types of construction prevailing in the various localities; however, these averages are believed to give a fair view of the general distribution of labor costs.

Life of Wire Bridge Cables

Satisfying assurance of the permanence of the three great suspension bridges across the East River at New York has been received recently as a result of a careful examination of those portions of these structures most frequently criticised, namely, the cables. Brought about by the necessity of removing the fabric wrapping of the Williamsburg bridge cables and replacing it by a wire wrapping of the same character as used for the Brooklyn and Manhattan bridges, a careful investigation of the condition of the wires under the wrapping of the cables for this bridge as well as for the other two was made by the Department of Plant and Structures of New York City. As interested parties, representatives of the engineering staff of the Philadelphia-Camden bridge made an inspection of the condition of the cables of the three bridges at the same time, and as a result of the conditions found, have indicated their confidence in the type of structure proposed at Philadelphia.

The indication thus obtained of the long life of wire bridge cables properly protected is merely one of many that have been available to the engineering profession for a long time. The 1,010-ft. wire cable suspension bridge built across the Ohio River at Wheeling, W. Va., in 1846 by Charles Ellet and later reconstructed by John A. Roebling, contains, for the most part the original cable material. After a use of 76 years this material is said to be in perfectly good condition. The Cincinnati and Covington bridge, constructed originally with two iron wire cables, and opened for traffic in 1867, still contains these original cables in excellent condition. When the Roebling railway suspension bridge was built across the Niagara River in 1855, use was made of the cable wire that had formed a part of the original Ellet structure built in 1848. Except for the necessity of cutting out a few dozen wires which had been badly exposed, the cables so constructed continued to do service till 1897, when the bridge was replaced by the present railway arch. The excellent resistance of cable wire to corrosion was also evidenced when the present Lewiston-Queenstown suspension bridge was built in 1899. On removing the old cables of the former structure, which had been built in 1851, they were found to be in an excellent state of preservation. In the new structure, cable wire which had been used in the upper suspension bridge at Niagara Falls, as reconstructed in 1889, was used.

In all the suspension structures built in America prior to about 1880 a clean, bright wire was used, usually dipped twice in boiled linseed oil, passed through an oiled sheepskin, on being unrolled from the reels prior to stringing and then carefully oiled in the strands before the wrapping was applied. With the construction of the Brooklyn bridge, however, from 1876 to 1883, advantage was taken of the newly established art of galvanizing. Both the strand wire and the wrapping wire were treated by the new process with results that have been shown to be excellent. Examination has shown that the Brooklyn bridge cables are as good as they ever were.

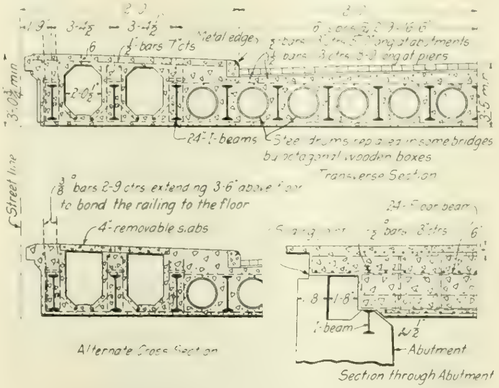
Believing that the experience with suspension bridges built prior to 1880 indicated a practically unlimited life for bright wire properly oiled, the engineers of the Williamsburg bridge decided to protect the cables by filling the spaces between the wires with "slushing oil," a hydrocarbon, to which was added 25 per cent of artificial graphite. Instead of covering the entire cable with wrapping wire, as had been done in the Brooklyn bridge, it was covered with four wrappings of canvas, heavily coated with the same bituminous material as filled the interspaces between the wires. To make the whole entirely waterproof and to protect it from the atmosphere, a 1/16-in. steel sheathing was placed outside the fabric. The experience of 20 years has shown, however, that this method of protection is inferior to that adopted by Roebling. The metal sheathing corroded and the canvas wrapping had hardened so that the motion in the neighborhood of the suspenders had caused it to break destroying the waterproof seal at these places. Fear of dangerous corrosion prompted the Department of Plant and Structures to remove the faulty covering and wrap the cables throughout with No. 9 Norway iron galvanized wire. With this protection, there is no doubt the life of the Williamsburg cables will be practically unlimited.

In the construction of the Manhattan bridge, completed in 1909, the Roebling method of cable protection was followed, although at that time there was no indication that the protective covering on the Williamsburg bridge cables would not be satisfactory. The farsightedness of the engineering staff in charge of bridge work in New York City at that time has been amply demonstrated in the excellent condition now found in the Manhattan cables.

It thus appears, as a result of an experience with wire cables in this country extending over a period of about three-quarters of a century, that even with the methods of protection devised for wire cables 45 years ago, there should be no doubt whatever so far as the cables are concerned, of the life and serviceability of the wire cable suspension bridge for centuries.—Editorial from The Canadian Engineer.

Weight of Bridge Floors Reduced by Use of Drums

Steel or wooden drums introduced in the floors of concrete overhead bridges constructed by the New York, Chicago & St. Louis Ry. in connection with a grade separation project at Cleveland, reduced the volume of concrete and thus not only aided in relieving the weight of the floor but also effected a decided saving in cost. The following details of this feature are abstracted from Railway Age:



Section Showing How Drums Were Located.

A standard plan of viaduct construction was developed and applied to all of the streets where it was possible to do so. Of the 13 bridges to be placed, 9 will follow the one type of construction, with slight variations to conform to the angles of the crossings.

The design of the concrete bridge structures is simple, being comprised of a 4-span structural steel bridge encased in concrete, each span opening being wide enough for two tracks. The substructure consists of mass abutments with piers of concrete encasing steel columns. The superstructure comprises longitudinal I-beams encased in concrete to form the floor. In the sidewalk structure the I-beams are encased separately with reinforced concrete slabs at both the top and bottom to provide public utility galleries. A concrete banister on each side of suitable design completes the viaduct. Under the original plan, at five of the bridges steel drums were introduced into the floor between the beams. Later developments showed that drums constructed of wood, which, needless to say, would be less expensive than steel drums, could be used with just as good an effect as the steel drums. Consequently, this type of drum is being used on the additional eight bridges.

Tensile Properties of Steels at High Temperatures.—A summary is being prepared by the U. S. Bureau of Standards of the data obtained on the various carbon and alloy steels which have been tested in the metallurgical laboratories of the Bureau, including the effects of normalizing rolled-low carbon steel, the effects of 1¼ per cent of manganese, the presence of 5 per cent cobalt, the addition of 0.4 per cent of molybdenum to carbon chromium steel, and the effect of various heat treatments on their properties. Progress has also been made in determining the effect of time-annealing at blue heat on the properties of cold-rolled boiler plate.

Designs and Specifications for Iowa Bridge Construction

New Developments of State Highway Commission for 1922 Work, Outlined in Paper Presented Before Iowa Engineering Society

By J. H. AMES,
Bridge Engineer, Iowa State Highway Commission

Prior to about 1909 practically all the bridges and culverts in Iowa were built of either wood, steel, wrought iron, or a combination of these three materials. A few unreinforced concrete and stone masonry structures had been built up to that time but in the aggregate their number was small. The plans and specifications for individual structures, where any were prepared, were provided by the bridge companies. Each bridge company doing business in the state possessed one or more sets of so-called standard designs and specifications which were placed on file when necessity demanded it. To say the least, these designs and standards were "flexible" and were prepared with little or no regard as to future loading requirements or traffic conditions.

Early Standards of State Highway Commission.—In about 1909 the commission began to consider the necessity for developing some standards of design and construction and of issuing some specifications which would insure uniformity of materials and workmanship. It was also at about this time that reinforced concrete began to assume importance as a construction material and that the motor vehicle was becoming of general use and necessitating consideration in the design of highways. These things largely influenced and made necessary the issuance of standard plans and specifications. With the limited funds at the disposal of the commission at that time not a great deal could be accomplished, although it should be said that the preliminary work done in those early days was pioneer work of considerable importance later and laid the foundation for much that we now have in the way of standardized practice. When the new highway law became effective in 1913 the Iowa commission had issued a rather complete set of standards covering the more common types of construction and had prepared and issued a set of standard bridge specifications in much the same form although not as complete as they exist today. At that time very few states had active state highway departments and even fewer had attempted to prepare any standard plans or specifications, or to exercise any control over construction work. It, therefore, fell to the lot of Iowa to "blaze the trail" in the matter of bridge designs and specifications and this has acted as an added incentive for this state to "set the pace" ever since.

In issuing the early standards there was little of anything in the way of precedent to follow. No other state had a set of well established standards which could safely be followed and no other state had similar topographic, economic or traffic conditions to meet. Naturally attention was directed to the development of standards along the same general lines as they had previously been applied to railroad construction and in doing so we inherited or perhaps "stole" from our professional brethren, the railroad engineers, much that we now have in the way of steel and construction details. Some that we took was good and we have used it generously and rendered little credit to them for it, but also some that we took was not good as applied to highway work and we have had some difficulty in divorcing ourselves from it. We have now arrived at a stage of development when we can with assurance separate the "sheep" from the "goats" and stand squarely upon what has been demonstrated to be good, sound engineering practice as applied to highway bridge work and without fear of giving undue influence to the past precedent of railway work. This fact will account for many of the changes which will be apparent in the 1922 edition of the standard specifications for bridge work and will, perhaps, be noticed in some changed details of design.

Experimental Stage in Highway Bridge Work Passed.—Before going farther I wish to emphasize one point, and that relates to the very brief period of time through which our present standards and specifications have been developed. It was just ten years ago that the commission issued the first set of standard plans and specifications. Yet, during that time owing to the intense application and very general use of this material much has been done to concentrate engineering thought and study upon these problems which otherwise might have reasonably occupied a long period of time. During that period of time over 35,000 individual bridges and culverts have been built under these plans and specifications with a total estimated cost above $30,000,000. I believe I am entirely safe in saying that we have passed from the experimental stage in highway bridge work where each individual engineer was cautiously feeling his own way to a more stable period where the conservative and well established practices of today will be changed only after the most thorough and painstaking investigation and research. I do not believe that we are likely to experience any spectacular developments in the immediate future but rather that the changes and revisions which will come will be those of a conservative nature intended to overcome some minor defects or to meet some new traffic or load condition. There is, of course, always the possibility that some new construction material will come into general use which might completely revolutionize designs as did reinforced concrete a few years ago, but I shall not attempt to enter the realm of prophesy.

The development of the standard designs and specifications as they exist today is not the thought and effort of any one individual, or even small group of individuals working together for a short period of time such as a year. Rather they represent the collective efforts and studies of many engineers in not only this state but in other states as well, who have aided in their development by their suggestions and criticisms. They reflect in a measure the economic conditions which have effected us during that time and, in fact, the whole trend of highway development. To those of us who have had some small part in their preparation and use they are representative of conservative practice and economical design as applied to the Mississippi Valley states. I assure you in the past it has not been altogether an easy matter at all times to harmonize the economic requirements imposed with the rapidly changing traffic conditions, with the future loading increases uncertain, with engineering and construction forces undeveloped, with disturbed industrial conditions due to the war and without precedent to follow. But I believe we have now reached a more or less stable period through which it will be possible to give more thought and attention to some of the refinements and details which are essential to a satisfactory and completed product.

Now to consider briefly a few of the changes, revisions and additions to our 1922 designs.

Loadings.—The possibility of future increases in loads exceeding those now in common use is being carefully considered by practically all of the state highway departments. At present our maximum live load in this state is a 15-ton road roller loading. Some apprehension has existed as to the possible development of the motor truck to where it might, under certain conditions and with added impact due to high speeds, overstress bridges designed for our present maximum loading. We have collected much information from truck, tractor and steam shovel manufacturers and from others which would indicate the present loadings and possible overloading. We have also through the co-operation of the engineers of the Bureau of Public Roads obtained a detailed statement from the present manufacturers as to possible future increase in loads. From these data and from other computations and studies now in progress we are trying to develop a standardized maximum loading which will provide for any reasonable increase in loading likely to occur. Should this new loading be materially different from those now in use it will require a complete revision of our present designs.

Impact.—The effect of truck and tractor loads moving at a maximum speed has been the subject of considerable study and investigation by the commission during the past summer and fall. Field tests on several types of bridges of recent design and under actual field conditions have been made with some very interesting results. These tests and investigations have not reached a point where the results may be said to be conclusive but they are strongly indicative of the necessity for impact consideration in future design. The tests will be continued as soon as weather conditions will permit and it is hoped that in the near future we may have some further data on this much discussed question.

Concrete Piling.—Material and construction costs have now decreased to a point where it may be economical and desirable under certain conditions to use reinforced concrete piling in trestle approach construction. This type of construction has found more general use in the eastern and southeastern states due to the necessity for protection against marine borers and on account of the many structures affected by tides and those located across swamps and low lying areas. We have not been able in the past in this state to interest contractors in this type of construction to the point of its economical use on account of the heavy equipment required in transporting, handling and driving the piles. A few individual locations are now being considered for the possible use of this class of construction and if its use proves economical and satisfactory its more general use may prove desirable.

Increased Roadway Widths.—The tendency towards increased roadway widths both for bridges and culverts might be mentionad as a factor affecting future designs. The 20 ft. minimum roadway width for bridges and 24 ft. minimum width for culverts on heavily traveled roads has now become so well established that further emphasis is not required. We should, however, be careful to provide adequate lengths of culverts at intersections on curves and under high fills. Recently we have revised our practice in determining culvert lengths so that the greater lengths of barrel will be provided in all cases, but particularly under the higher fills. Experience has indicated the necessity for these changes and designs prepared under the new requirements should prove adequate except in the unusual cases.

Concrete Pipe Culverts.—New standard requirements governing the use of concrete pipe culverts will be issued in the near future. These will be in general conformance to the requirements adopted by the Joint Concrete Culvert Pipe Committee and based on the recent investigations conducted by the Engineering Experiment Station of Iowa State College on culvert pipe loadings. These new requirements have been delayed somewhat awaiting the results only recently available and sufficient data are now available to permit the issuance of these detailed requirements.

Structures for the Secondary Road System.—A word might well be added here in reference to the necessity for further thought and study as to the problems of bridge design and construction on the secondary system. These structures demand careful consideration as to their safety and convenient use. They are often subjected to heavy loads from farm tractors and threshing machine outfits, and it is essential that proper provision be made for keeping them in good repair. Bituminous floor coverings are being used with success in some of the counties for maintaining good surfaces over plank floor and for protecting these floors against excessive wear and from decay. A further study of the possible use of such materials as well as the general requirements for structures on the secondary system will be made by the Commission this year.

Many other details of a minor nature might be added to the list just given, but these probably represent the major changes in design likely to occur this year.

New Specifications Will Give Much More Detail.—It is impossible to foretell at this time to what extent the 1922 edition of the standard specifications for bridges and culverts will be revised. The new specifications are now being prepared and much work remains to be done before they may be issued in final form. It may be said with assurance, however, that the new specifications will be much more in detail than any previous edition, also that the general form and arrangement will be materially altered so as to make reference to them much easier.

It is contemplated that the new edition when issued will follow the general outline prepared by the sub-committee on bridge standards of the American Association of State Highway Officials, which outline was adopted at the Omaha meeting last December. This outline is to form the basis for the bridge specifications of the several states of the Union, and it is expected that in future revisions most, if not all, of the states will follow the general outline as adopted. Iowa is the first state to attempt to revise their specifications under the new outline and the work of "blazing the trail" is slowing up the actual issuance of the specifications to some extent. I am confident that those of you who make frequent reference to the specifications will find the arrangement of the 1922 edition much more satisfactory than past editions, and will heartily indorse the change. A complete index which will accompany the specifications will also facilitate reference greatly. It is also quite probable that the new specifications when issued will be in sectional form. Each section will cover a complete part of the specifications and this will not only add to the ease in locating similar material, but will also permit future revision by sections rather than revising all of the material at one time.

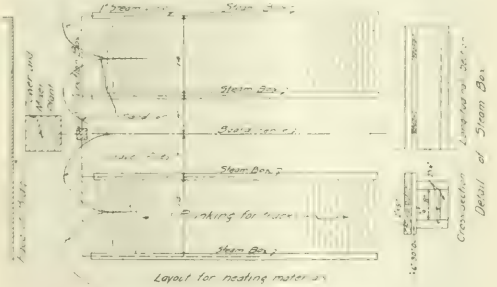
The general clauses and material sections will both be considerably increased in size and will cover points not included in the present specifications. Some forms of general use will be added to the section on forms and those now in the specifications will be revised to some extent.

In summarizing the work being done on the new bridge and culvert specifications it might be said that the principal changes will be in form and arrangement with considerable new material added. The changes in the detailed requirements now found in the present specifications will in general be only corrective in nature and with the idea in view of eliminating insofar as possible points of difference between the engineering and contracting forces.

Steam Box Arrangement for Heating Concrete Materials

Steam boxes made of plank are being employed by William Steele & Sons Co. for heating the aggregate for a 3-story flat slab job at Kensington avenue and M street, Philadelphia. The arrangement is described in Successful Methods from which the matter in this article is taken.

Four 1-in. steam lines, connected to a junction box near the mixer plant, enter each of the lines of steam boxes and project into them approximately half way. The covers of the boxes are made up of 2-by-8's which project slightly over the box proper. A 1-by-6 crosspiece on about 30-in. centers forms an opening through which the steam escapes to the material piles. The projection or overhang prevents the material from getting into the boxes and at the same time there is no chance of clogging which is a great advantage over the box in which holes are bored. From the construction it is seen that it is sufficiently strong and that there is no chance of a collapse. Another advantage of this particular layout is that the piles are arranged in parallel so that, should one box be stripped the other would be available.



Layout and Details of Steam Boxes.

Production and Price of Lime in 1921.—About 2,531,000 short tons of lime, valued at $24,536,000, was sold in the United States, including Hawaii and Porto Rico, in 1921, according to an estimate made by the U. S. Geological Survey, from reports made by the principal producers. This quantity is less than that sold in any year since the survey has collected its statistics and is 29 per cent less than that sold in 1920. The average value per ton in 1921 is estimated at $9.69. In 1920 it was $10.52, and in 1919 it was $8.84. The sales of hydrated lime in the United States in 1921 were estimated at 737,000 short tons, a decrease of less than 14 per cent as compared with those in 1920, whereas the sales of quicklime (including refractory lime or dead-burned dolomite) were estimated at 34 per cent less than in 1920. The estimated value of the hydrated lime sold in 1921 was $7,673,000, an average per ton of $10.41. The average value per ton in 1920 was $10.89.

Standardization of Building Codes

At the annual meeting of the Associated General Contractors of America at Cleveland, Jan. 17-19, the Committee on Codes submitted a suggested outline for a standard building code prepared by R. C. Marshall, Jr., general manager of the Association. The outline of standards follows:

Outline for Standard Building Code.—1. Scope. The code should be prefaced by a statement as to its applicability.

(a) As to time. It should include all future work and may be in certain respects retroactive.

(b) As to character. It should include all permanent buildings, fences and billboards, etc., and not only the finished structures but also during the period of erection.

(c) As to extent. Definition should be made as to how much (if any) alteration may be made to any present building or structure without bringing it under the scope of the code.

The main portion of the code falls under three heads:—

Requirements, giving the information necessary to make the general plans for any specific building.

Construction, giving the information necessary to make the working drawings for all buildings.

Administration, giving the methods by which the code is enforced.

PART I—REQUIREMENTS.

Requirements as to Occupancy.—As practically all buildings are erected for a certain definite character of occupancy, such as residence, theater, storehouse, factory, etc., the code proper should commence with a statement of its general requirements for buildings of every class, leaving the details thereof to be explained in subsequent sections. In order to avoid confusion, the names used to describe occupancy should be defined exactly and exhaustively; for instance, the line of demarcation should be carefully drawn between tenement houses, apartment houses and hotels, between loft building, factories and stores, between churches, lecture halls and theaters. Care should be taken to define the status of buildings whose occupancy does not fall in any well-defined category such as bathhouses, jails, railway stations. Provision must be inserted to cover buildings of more than one character of occupancy, such as retail stores with apartments in the upper stories, etc. The requirements as to occupancy fall under the following heads:

(a) **Location.**—Limitations on occupancy may be imposed in the various zones of the city; thus factories may be excluded from certain neighborhoods, and those causing unpleasant odors or noises may be restricted to a zone of their own.

(b) **Types of Construction.**—Different occupants require different types of construction for exterior walls, floors, roofs, partitions and stairs. The usual method of prescribing types of construction in existing building codes is to group buildings as a whole into four or five classes, such as fireproof, ordinary, and frame. For comparatively few classes of occupancy does a building run true to type, so that the general definition for each type of construction is loaded with exceptions. It is therefore suggested that a simpler and more exact method is to define four or five types of construction for exterior walls, partitions, interior columns, floors, roofs and stairs separately and to prescribe for each class of occupancy which type shall be used. It should be noted, however, that very frequently more than one type of wall or floor, for instance, may be prescribed for the same building; thus, an occupancy allowing ordinary frame partitions between the rooms may yet require fireproof or fire-resistive partitions around the stairway and elevator shaft. It should also be noted that the type of construction required by the occupancy may be modified by other considerations such as the height or location of the building, as provided in Section 3, b.

(c) **Allowable Loading of Floors.** Most codes specify certain loads for which floors of different occupancies are to be designed, these figures to be used for joists, girders or columns. For buildings where the whole floor may be loaded uniformly, this is necessary. However, in residences a row of persons, and in others a safe may load heavily one or two beams, but there is no likelihood of the whole floor being so loaded. For such occupancies it is therefore recommended that the girders be calculated for a much lighter load than the joists. Allowance should be made for vibration in cases of floors used for dancing, marching or machinery.

(d) **Safety Provisions.**—I. Miscellaneous arrangements of plan: such as limitation of area of space between firewalls, etc., provision for rest rooms for women in factories and the location of workshops and property rooms in theaters.

II. Means of egress: number and size of doors, and when they should open outward, width and slope of aisles in churches and theaters; stairs, their number, width and steepness; fire-escape, their number and location (details of construction to be given later). This section should provide for exits to roof, and from sidewalk vaults and from yards or lightwells.

III. Fire-fighting appliances, such as sprinkler systems, standpipes with hose reels and chemical extinguishers, when required.

(e) **Light and Air.**—I. Dark rooms: the uses to which they may be put should be given, both when the rooms are and are not provided with a specified amount of indirect ventilation. (In this connection, the word room should be defined so as to prevent evasion of the code by construction of unauthorized alcoves, etc.)

II. Size of windows: the size of window and the amount thereof to be capable of opening for ventilation should be given for such occupancies as sleeping rooms, workrooms and places of public assembly, preferably in terms of the size of the room. Where indirect ventilation is permitted instead of windows, its amount and character should be given.

III. Cubic capacity: the number of cubic feet required per person in places of public assembly and in workrooms should be given—the latter will vary with different industries. A minimum size should be specified for sleeping rooms.

IV. Size of light shafts: for buildings on interior lots (or portions of corner lots more than a certain distance from the corner) whose rooms require windows, the amount of lot to remain open to the sky above the second story window sills should be stated. This should increase as the height of the building increases.

(f) **Sanitary Provisions.**—I. Water supply: when to be furnished and number of wash basins required. Hot water to be furnished in certain factories.

II. Water-closets: when to be installed and ratio of number required to number of occupants.

III. Use of cellars: how permitted (line must be drawn between cellar and basement.)

3. Requirements Other than Those from Occupancy: This subject should occupy the next chapter of the code. It divides itself into the following headings:

(a) **Restrictions on Height.**—This is usually determined by the zone in which the building is located or by the width of the street on which it fronts. It should be given in feet rather than in stories and should be calculated from the top of curb (average curb if street is on a grade) to top of the front wall. Height of pent houses and roof structures should be governed by a line sloping back from the top of the front wall at a given angle.

(b) **Restrictions on Types of Construction.**—These may be determined by the zone in which the building is located, or by the exposure (i. e., the width of the street on which it faces or its distance from other buildings) or by the height of the building.

(c) **Projections Over Building Line.**—I. Cornices, string courses, balconies, bay-windows, porticos, marquees, steps and areaways: the projection of steps and areaways, if allowed, is usually given as a percentage of the width of the sidewalk. Porticos are usually restricted to a percentage of the frontage of the building. Marquees may usually project to the curb, but must be a given height above the sidewalk. Continuous string-course, balconies or cornices (except the main cornice) are usually allowed to project a foot or two. The projection of main cornices should be governed by the height of the building and the width of the sidewalk. Isolated balconies may project several feet but should not cover more than a given percentage of the frontage. Provision should be made to collect rain water falling on roofs, cornices, marquees and balconies, and to dispose of it so that it is not discharged upon the sidewalk. It is also suggested that the upper surface of window sills and string courses be so sloped as to prevent the accumulation of snow or the standing thereon of articles liable to fall upon passers-by.

II. Projections under the sidewalk: If the street is likely to be occupied by a subway, the projection of foundations beyond the building line should be prohibited. The space below the sidewalk may usually be occupied by a vault, but if this is permitted it should be by revocable license. It is not uncommon to reserve a given space between the curb line and the outer side of the vault for pipes and conduits.

III. Party walls: their construction should only be permitted where, by mutual agreement between adjoining owners, they become an easement and their demolition is not allowed except by mutual consent; but the channeling of such a wall for columns should be permitted. A minimum distance between the party line and the ends of beams resting on such a wall should be prescribed. The method of strengthening such walls by underpinning and addition of extra thickness should be given in detail.

IV. Carrying up chimneys: where a new building is built contiguous to and higher than a wall in which there are flues, it is usual to require that those flues be carried up to the level of the new building by the owner of the latter, at his own expense.

PART II—CONSTRUCTION.

4. **Structural Design.**—The necessary data are:

(a) The loading for which floors must be calculated. These have already been given, but in tall buildings where the live load is comparatively small and shifting, however, it is usual to neglect a portion or all of it in designing the foundations and the columns of the lower stories.

(b) Roof loading and wind pressure.

(c) Allowable bearing on soils.

(d) Allowable stresses on materials.

(e) Formulae to be used.

5. **Details of Construction.**—This section should prescribe those features which it is not possible to obtain by calculation, but which experience has shown to be necessary. They are best segregated into portions of the building thus:

(a) Foundations.

Protection of steel against corrosion, details of caisson construction, types of concrete or composite piles.

(b) Walls and partitions.

Minimum thicknesses, combination of different materials, skeleton and cage construction, bonding, hollow walls, recesses and chases, arches, parapets, fire-stops in studding.

(c) Floors.

Bearing of beams, beveling of ends of joists, bedding of sleepers, provision against dry rot, framing around chimneys and hearths, provision for disposal of water from fire hose (scuppers).

(d) Roofs. Guards on skylights.

(dd) Towers, turrets and spires.

(e) Stairs. Height of hand rail.

(f) Chimneys and fireplaces.

(g) Installation of heating apparatus.

(h) Plumbing and drainage regulations.

(i) Installation of electric wiring and apparatus

(j) Elevators and dumbwaiters and their enclosures

(k) Gasoline storage tanks.

(l) Theater curtains.

(m) Flagpoles.

(n) Roof signs.

(o) Fences.

(p) Parade stands.

6. **Specifications of Materials and Workmanship.**—This section should follow the lines of an architect's specification, but prescribing only those features necessary for safety and security.

(a) Masonry.

Quality of brick, stone, terra cotta, cement, sand, etc.; Method of mixture of motor and concrete. Quality of reinforcing steel and method of placing. Location of points for stoppage of work and expansion joints.

(b) Steelwork and cast iron.

Quality of materials, detail of connections, protection against corrosion.

(c) Carpentry.

Quality of material, method of framing.

7. **Methods of Construction.**—This section refers to the processes to be followed during the actual erection of the building.

(a) Shoring and underpinning.

Shoring of sides of excavation and of walls of adjoining buildings. Underpinning walls to deepen foundation.

(b) Concrete forms.

Method of making and removing. Length of time to be allowed for setting of concrete.

(c) Protection of passers-by.

Sidewalk platforms.

(d) Protection of workmen.

Guards at elevators, construction of scaffolds.

(e) Demolition of buildings.

(f) Temporary safeguards for unsafe buildings.

PART III—ADMINISTRATION.

8. **Enforcement of the Provisions of the Code.**—This should be placed in the hands of a Superintendent of Buildings, who should be appointed for a long period, say ten years, subject to removal only for cause, and who should have the necessary assistants of his own selection to enable him to execute the following duties and powers:

(a) **Interpretation of Code.**—He should issue regulations interpretative of the code; if necessary, establish tests to be used to determine the qualities of material and conduct tests of new materials. He should have the right to decide if and when materials and forms of construction not covered by the code should be used.

(b) **Permits to Construct.**—No construction should be started without a permit, to be issued after the plans and specifications have been examined to determine whether they fully comply with the code. Applications for permits should bear the consent of the owner.

(c) **Inspection of Work.**—Provision should be made for frequent inspection during construction, and means provided to rebuild work done in violation of the code and to immediately correct any condition which is dangerous.

(d) **Certificates of Occupancy.**—No building should be occupied until a final inspection is made and a certificate issued to show that the building complies with the provisions of the code and is considered thereby suited for the purpose for which it is intended. This certificate should be required to be kept in evidence, and no change of occupancy permitted without the necessary alterations and a new certificate.

(e) **Building Surveys.**—Provision should be made for periodic inspection of completed buildings to see that they are safe and suitable for the purpose for which they are being used. Powers should be granted to cause corrections of any faulty condition, immediately, if necessary. A fund should be provided for emergency work of this character.

(f) **Procedure in Case of Disaster.**—It should be the duty of the police to summon a representative of the Superintendent of Buildings in cases of collapse of buildings and all rescue or demolition work should be under his direction.

(g) **Appeals.**—Right of appeal should be granted from the decisions of plan examiners or inspectors to the Superintendent and from his decisions to a Board of architects, engineers and builders.

Retail Prices of Food Decrease

The U. S. Department of Labor, through the Bureau of Labor Statistics, has completed the compilation showing changes in the retail cost of food in 27 principal cities of the United States. During the month from Dec. 15, 1921, to Jan. 15, 1922, there was a decrease in all of these cities, as follows: In Salt Lake City and Savannah, 9 per cent; in Providence, 8 per cent; in Manchester, New Haven and New York, 7 per cent; in Louisville, Milwaukee, Minneapolis, Norfolk, Pittsburgh and Rochester, 6 per cent; in Birmingham, Chicago, Columbus, Peoria and Seattle, 5 per cent; in Baltimore, Kansas City, Little Rock, Philadelphia, St. Louis, Springfield and Washington, D. C., 4 per cent; in Cincinnati and Indianapolis, 3 per cent; in New Orleans, 1 per cent.

As compared with the average cost in the year 1913, the retail cost of food on Jan. 15, 1922, showed an increase of 50 per cent in Washington; 48 per cent in New York and Providence; 46 per cent in Baltimore and Manchester; 45 per cent in Chicago; 44 per cent in Birmingham, New Orleans and Philadelphia; 43 per cent in Kansas City; 42 per cent in New Haven; 40 per cent in Cincinnati, Milwaukee and Pittsburgh; 38 per cent in St. Louis; 36 per cent in Indianapolis and Minneapolis; 35 per cent in Little Rock; 31 per cent in Louisville; 29 per cent in Seattle; and 21 per cent in Salt Lake City.

Summary of Income Tax Rates and Requirements

[Income tax returns must be filed with the Collector of Internal Revenue, and the first installment paid not later than March 15. The entire tax may be paid in one installment or divided into 4 equal payments as desired. Because of the many questions arising on this subject at this time of year, we print the following summary which appeared in the February issue of "Lefax." It was prepared by Lefax from an Explanatory Digest by Wagner, Rockey and Co., Certified Public Accountants of Philadelphia.—Editor, Engineering and Contracting.]

Net Income and Computation of Tax.—(New Revenue Act of 1921) An individual is taxed on taxable net income. Under the act the net income is determined by deducting from statutory gross income all the deductions permitted by law. The net income is subject to both a normal income tax and a surtax.

Gross Income.—Gross income includes all gains, profits, and income derived from any source whatever, whether legal or illegal, but does not include the following:

Exempt Income.—(1) The proceeds of life insurance policies paid upon the death of the insured.

(2) Amounts received as a return of premiums paid under life insurance, endowment, or annuity contracts.

(3) Property acquired by gift, bequest, devise, or descent. (The income, however, from such property is taxable.)

(4) Interest upon the bonds of a state or territory or political subdivision, or of the United States if issued before September 1, 1917. (United States bonds and War Finance Corporation bonds issued after September 1, 1917, are exempt only to the extent specially provided by law. See Chart.)

(5) Income of foreign governments.

(6) Amounts received as a result of personal injuries or sickness from insurance or suit.

(7) Income accruing to a state or territory or political subdivision from the operation of any public utility or of any essential governmental function.

(8) The income of a nonresident alien or foreign corporation which consists exclusively of earnings derived from the operation of a ship or ships documented under the laws of a foreign country which grants an equivalent exemption to citizens of the United States and to corporations organized in the United States.

(9) Amounts received as compensation, family allotments and allowances under the War Risk Insurance and Vocational Rehabilitation Acts, or as pensions from the United States for services of the beneficiary or another in the military or naval forces of the United States in time of war.

(10) Dividends or interest not in excess of a total of $300 received by an individual, after December 31, 1921, and before January 1, 1927, from domestic building and loan associations, operated exclusively for the purpose of making loans to members.

(11) The rental value of a dwelling furnished to a minister as part of his compensation.

(12) The receipts of shipowners' mutual protection and indemnity associations, not organized for profit (but net income from interest, dividends and rents are taxable).

Income from Salaries.—The compensation an individual receives for personal services is taxable income, regardless of the form in which it is paid.

Liberty Bonds.—All of the contingent exemptions and several other exemptions on other Liberty Bonds have been abolished and, in lieu thereof, a general exemption of the interest on any 4's or 4¼'s on an aggregate principal amount of $125,000 is exempt from January 1, 1921, until two years after peace is proclaimed by the president and for three years more on an aggregate principal amount of $50,000.

The president issued his proclamation of peace on November 14, 1921, but made the proclamation retroactive to July 2, 1921, thereby officially terminating the war with Germany on July 2, 1921.

Deductions.—A taxpayer is allowed to deduct all the ordinary and necessary expenses of business such as reasonable salaries, rental and depreciation on business properties. The depreciation should be computed on the basis of cost, or if acquired prior to March 1, 1913, on the fair market price on that date.

Interest.—A taxpayer can deduct all interest paid or accrued during the taxable year except on indebtedness incurred or continued for the purpose of carrying securities the income from which is not subject to tax. The taxpayer, however, is specifically permitted to deduct the interest for obligations incurred to carry United States tax exempt securities issued after September 24, 1917, provided that he was an original subscriber to such bonds.

Taxes.—An individual can deduct taxes imposed on his interest as a shareholder which the corporation pays on his behalf and for which it receives no reimbursement.

Wash Sales and Losses.—When sales are made for taking a loss and immediately thereafter the property is re-acquired the sale is popularly known as a "wash sale." In such a case you cannot deduct the loss.

Losses.—Losses from business transactions, fire, storm, shipwreck, or other casualty or theft (whether or not connected with the business) are deductible. Before determining the amount of deductible loss, it is necessary to reduce the loss by the amount of any insurance received.

Reserve for Bad Debts.—The new Act provides that, in the discretion of the Commissioner, a reasonable addition to a reserve for bad debts may be deducted.

Amortization.—No claim may be made for the amortization of assets constructed after 1921 unless a claim therefor was made at the time of filing the 1918, 1919, 1920 or 1921 return. The allowance for amortization must be determined before March 3, 1924.

Contributions.—This provision has been extended to include not only gifts to religious, charitable, educational or scientific organizations, and the vocational rehabilitation fund, but also to posts of the American Legion, or to a community chest, fund, or foundation organized and operated exclusively for religious, charitable, scientific, literary, or educational purposes. Charitable contributions of this character may be deducted to an amount not in excess of 15 per cent of the net income of the individual before this deduction.

Items Not Deductible.—Capital Expenditures.—Amounts expended for new buildings or permanent improvements are not allowable deductions.

Premiums On Life Insurance.—Where the person paying the premium on a life insurance policy is either directly or indirectly the beneficiary, the premiums are not deductible.

Personal, Living or Family Expenses.—These expenses are not deductible.

It should be noted here that an individual may not deduct as an expense the rent of his residence, but if he owns the residence, he may deduct the taxes he pays thereon, as well as interest paid on mortgages on the property.

Proprietor's Salary.—While a proprietor of a business properly may deduct his salary as an expense of the business on his books, he should not do so in reporting the income of his business on his tax return.

Rent.—All rent paid or accrued for the use of property in connection with the business of the taxpayer may be deducted. Rent of living quarters or residence may not be deducted.

TABLE 1—RATES FOR 1921 AND 1922

(Chart shows the tax payable by a married person or head of family, but does not take [illegible] of any exemption for dependents.)

Net Income	Total Tax 1921	Total Tax 1922 and thereafter.	Net Income	Total Tax 1921	Total Tax 1922 and thereafter.
[illegible]	0	0	[illegible]	10,490	9,900
[illegible]	0	0	[illegible]	11,150	10,560
[illegible]	$20	$20	[illegible]	11,870	11,240
[illegible]	60	60	[illegible]	[illegible]	11,940
[illegible]	100	100	[illegible]	[illegible]	12,660
[illegible]	[illegible]	160	[illegible]	[illegible]	13,400
[illegible]	[illegible]	[illegible]	[illegible]	14,870	14,160
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14,940
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	15,740
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16,560
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	17,400
[illegible]	[illegible]	1,410	[illegible]	[illegible]	18,260
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	19,140
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	20,040
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	20,960
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	21,900
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	22,860
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	24,840
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	29,040
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	58,140
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	86,640
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	111,640
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Methods of Reinforcing Phoenix Columns for Elevated Railway

Interesting methods were employed in reinforcing the lower ends of about 200 columns for one of the elevated railways in Brooklyn, N. Y. These columns are of circular cross sections, made up of six circular shaped steel plates riveted together vertically. The reinforcement was made necessary by the corrosive action on the columns of rainwater which entered through an opening between the columns and the cast iron wheel guards around the feet of the columns. The methods are described by Joseph Harris, junior engineer, Transit Construction Commission of New York City, in the February Cornell Civil Engineer, to which we are indebted for the matter in this article.

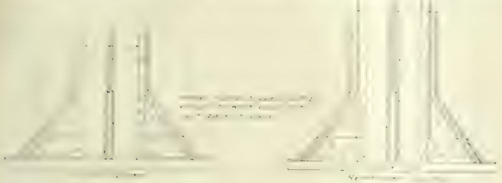


Fig. 1.—Reinforcing Columns by Riveting Steel Plates on Each Side of Joints.

The methods used in reinforcing the columns may be divided into two types as shown by Figs. 1 and 2.

In type one, shown on Fig. 1, the reinforcement consisted of riveting a steel plate $\frac{1}{2}$ in. by 3 in. by about 3 ft. on each side of the six column joints. The cast iron wheel guard was raised up, by sliding it over the column with the aid of hooks and ropes, the ropes passing through a tackle fastened to the cross girders, to a height of about 10 ft. Since in this type the column base was below the street level, the pavement was broken up for 2 ft. on each side of the column and for a depth sufficient to expose the column base. The plates were then riveted on, the lower ends resting on the column base. Concrete was then poured in the excavation to within 6 in. of the pavement. A circular steel collapsible form was then used for this purpose. The cast iron wheel guard was lowered, after this concrete had set, and then filled with cement grout to within 3 in. of the top. The remaining 3 in. were then filled in with a bituminous mixture going under the trade name of "Healing Cement." This cement is supposed to expand and contract with the changes in temperature, and does not become brittle and crack, thus keeping the water out of the wheel guard.

In the second type of reinforcement, shown on Fig. 2, the columns set into large cast iron bases. The method of reinforcing the columns here was as follows: A tapered steel plate ½ in. thick, about 2 ft. 3½ in. long and tapering from 4 in. at the bottom to 2 in. at the top, was riveted on each side of the six columns through an opening made in the side by cutting out a section about a foot square at a point 4 ft. above the base of the column. These reinforcing rods were held in place by wire spacers. Concrete was poured into the columns around these rods and the section of steel plate, which had been cut out, replaced. Grout was then poured in on top of the concrete joints. Seven 1 in. twisted steel reinforcing rods about 6 ft. long were inserted into the columns through a small hole drilled for that purpose in the column so as to thoroughly cover the reinforcing rods. In addition, six ¾ in. bolts were inserted through the column horizontally. The cast iron wheel guard was then replaced and filled with concrete as in type one. Since the reinforcing rods extend from the base of the column to a height of 6 ft. and are incased in solid concrete this makes what is practically a reinforced concrete section 6 ft. high for this type of column.

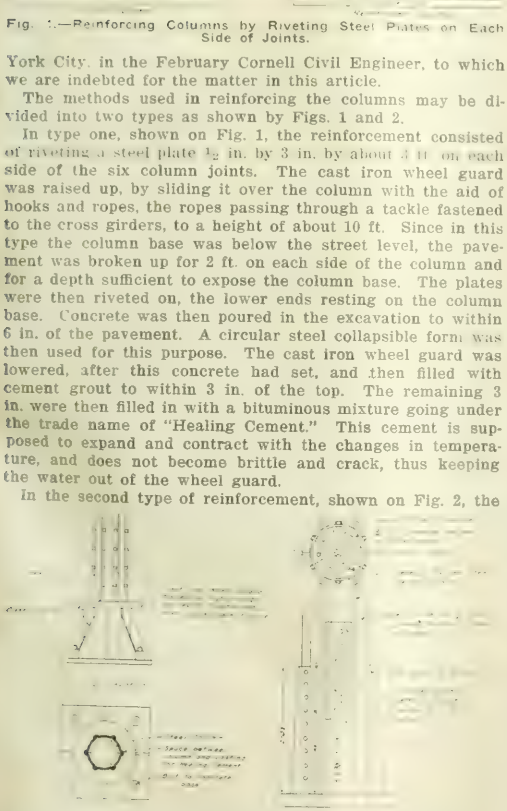


Fig. 2.—Reinforcing Columns by Stiffener Plates and Concrete.

Remodeling Old Building to Meet Modern Office Requirements

The remarkable manner in which buildings may be remodeled to meet the present-day requirements for offices was exemplified recently in the reconstruction of the Washington Building, 1 Broadway, New York City, states the Contract Record.

This building was built in the early eighties. It was 14 stories high and of bearing wall construction, the floors being supported by the walls and interior cast iron columns. The foundations for the most part went down to rock and the walls laid up in good cement mortar which was somewhat unusual for buildings constructed in those days. It was found on examination, however, that the brick piers between windows were cut into by recesses for pipes, chimney flues, etc., so that great care had to be taken not to overload the brickwork. For this reason an enormous amount of shoring and scaffolding was used when the old brick was being replaced by Indiana limestone.

The main structural feature of the reconstruction was the removing of an entire row of eight columns, and two others, or ten in all, for three tiers, leaving a clear space between the Battery Place wall and the court wall. To do this it was necessary to carry the 11 stories above on large plate girders to the wall columns. The old ground floor was removed and a new floor put in about a foot higher. This floor was carried on new plate girders running from one wall to the other. They were made double, one on either side of the column which was later removed. The old second floor was removed together with the columns above and below it. The girders on which the old columns were to rest were composed of a 48x⅞ in. web plate, two 8x6x1 in. flange angles and four 21x⅞ in. cover plates for each flange. They were 41 ft. 9½ in. long.

An elaborate system of shoring was arranged to raise the girders and hold them in place in case an accident should happen to the hoisting apparatus. They were raised by means of wooden Howe trusses, which rested on the second floor from which a chain block arrangement hung. As the girders were raised into position, a timber-crib blocking was built up near each end so that the girder could not fall more than a few inches. One of these girders was raised to the required height on either side of the column to be removed and a very heavy bracket was riveted to the column, resting slightly above the girder. In this space six steel wedges were placed, three between each bracket and girder. These wedges were 33 in. long, 6½ in. wide and 1½ in. thick at the butt, tapering down to about ⅛ in. at the other end.

The wedges were driven in until the ultimate deflection of the girder had been obtained. If this was not obtained before the wedges had been driven in as far as possible, two pair were driven in a little farther to allow the other pair to be taken out. A shim plate was inserted and the wedge driven in again. This operation was repeated for the other two pairs. In this manner the entire weight of the 11 stories above was transferred from the column to the girders, the wedges being used to assure that the ultimate deflection had occurred before the columns were removed. The wedging was spread over two weeks and the girders were deflected from ¼ in. to 25/32 in.

Th next operation, after it was evident that the girders were carrying all the load, was to burn off the heavy cast iron columns. This was done by means of an acetylene gas torch. When the columns were removed, each pair of girders was connected by a pair of plate-girder diaphragms directly under the column. The space between the girders and the diaphragms is to be filled with concrete and the cast iron columns above are to be filled with grout or concrete up to the top of the bolts, from the brackets to avoid any danger of the latter rusting out.

Experiences of Santa Fe Ry. with Creosoted Timber*

By A. F. ROBINSON,

[illegible] Atchison, Topeka & Santa Fe Ry.

Our first creosoted piles were used in 1875 in an open deck pile bridge built across Galveston Bay. The first creosoted ballasted deck pile bridges were put into service on the Santa Fe late in 1899. The same season creosoted timber flooring was used on a ballast deck steel bridge at Los Angeles. When the joint track elevation bridges were built at Chicago, creosoted timber flooring was used to support the ballast. Following 1900 the use of creosote increased very rapidly, as by 1908 almost all timber used in bridges was creosoted.

Earlier Treatments. From 10 to 12 lb. of creosote per cubic foot of timber were first used for structures on land or fresh water. For structures in salt water a much heavier treatment was required. At present piles for marine service receive a light steaming and then from 20 to 25 lb. of creosote per cubic foot of timber are forced in, or all the creosote the timber will take. For about 10 years southern pine has been treated by the full cell process, some 14 to 16 lb. of creosote per cubic foot of timber being used. At all of the Santa Fe treating plants southern pine for land structures is air seasoned and then creosoted without steaming or temperature. When we commenced using creosoted material the treating was done at commercial plants and the timber was steamed.

Our bridge list as of Jan. 1, 1921, shows the following single track lengths of bridges. Arches, boxes and pipes are omitted, but T-rail bridges are included.

[illegible] lin. ft. of open deck timber bridges.
[illegible] lin. ft. of ballast deck timber bridges.
[illegible] lin. ft. of open deck steel bridges.
[illegible] lin. ft. of ballast deck steel bridges.
[illegible] lin. ft. of reinforced concrete bridges.

[illegible] of all bridges [illegible] about 188 miles.
[illegible] of the ballast deck steel bridges have creosoted tim[illegible]

The creosoted ballast deck timber bridges from 16 to 20 years old seem to be in perfect condition and give promise of being good for from 15 to 20 years more. These may, therefore, be considered as permanent structures. Some 38 per cent of all our bridges are ballast deck and almost 50 per cent will be termed permanent structures. For main lines alone, the percentage of ballast deck bridges is now 68 per cent. No open deck bridges of any kind have been built on the main lines during the last 10 years, except after washouts or burnouts.

Creosoted timber bridges had not been in service very long before we found that there were many things to be learned about cutting, handling and curing before treatment; also, handling the treated material and building the bridges. During 1909 and 1910 we had a good many complaints about rotten piling on the Beaumont division, which extends from Somerville, Tex., to Longview, Oakdale, Beaumont and Port Bolivar. In this territory timber seems to be more readily affected by decay than in any other part of the country traversed by our lines.

A few miles east of Cleveland, Tex., we have what is known as an experimental section, where we try out all kinds of treatment on ties, fence posts, etc. This section was taken because the soil and climate seemed to be especially adapted to produce rot in timber both treated and untreated. On this section I found at least 2,000 piles that were rotting very badly. The piling and timber used had been treated in commercial plants between 1900 and about 1907. Up to that time no rules had been made covering the time the material might be left in the woods after cutting or the time it was to be cured before treating. I think many piles had been left in the woods several months and the material had actually commenced to decay before it was taken to the treating plant.

Piling Troubles and the Remedies.—Piles, after being driven in the bents are sawed off for capping and our plans called for these freshly cut surfaces to receive a heavy treatment of hot creosote before the caps were applied. Notwithstanding this we found a large per cent of the piles were beginning to fail at the caps. There would be an outer layer or ring of creosoted sap wood which was good, but inside this there would be a ring of untreated sap wood which was rotting very rapidly. In many cases a good deal of load was being carried by the outer creosoted ring of sap wood and but very little load by the heartwood. We found a good many cases of rot starting at or near the ground surface. Decay also commenced in holes bored for sway brace bolts and for other purposes. It would always start wherever the creosoted surface was disturbed or bruised deeply.

Our men had the unfortunate habit of chamfering the sides of the piles at the cap so they would drain. Frequently they would cut out large chips or sections from the side of a pile in order to make the sway braces draw straight, and in every case of this kind decay seemed to start very promptly, as the cut in the timber usually extended through the creosoted layer. Careful study seemed to show that the cause of decay was due to leaving the heads of the piles or some other portions unprotected or untreated.

Another source of trouble was the driving of the piles. I found a good many cases where the heartwood had been broken loose from the sap. In the ordinary steam hammer the lower end, about 12 in. in diameter, projects through the driving block and strikes the pile. A circle 12 in. in diameter has a little more than one-half the area of a 16-in. circle and only about two-fifths the area of one 18 in. in diameter. From this you will note that the blow from the hammer was being delivered to the pile over an area of less than one-half its surface. The skin friction on the outer surface of the pile would hold it up and the hammer would drive the heartwood loose. We overcame this by providing a driving head 18 in. in diameter which rested squarely on the head of the pile, and was so arranged that the blow from the hammer must be distributed over the entire surface of the pile.

As a remedy for the above troubles we cut down the piles to good solid material and inserted framed bents or blocking at varying heights. When the piles were sawed the freshly cut surfaces were treated with three or four coats of hot creosote mixed with heavy road oil. A sheet of some kind of prepared roofing was then applied over the fresh coating, after which the creosoted timber bent was put into position and drift bolted to the piles. These repairs were made more than ten years ago and up to present writing we have not been able to detect any more indications of decay.

When we cut out these piles the cross sections were examined very carefully and it was found that the creosote had penetrated the piles very irregular. On one side the treatment would be almost as thin as a sheet of paper and on the other side it might be 2 in. thick, the thickness of the treatment varying all around the surface of the piling. We figured that this was due to moisture in the piling, which resulted from the steaming and the improper seasoning. At our own treating plant at Somerville all material except that used in marine work is carefully air cured and receives no steaming of any kind. As the result of this handling, we have been able to get a very uniform penetration of the creosote. On the other parts of the Santa Fe system we have had very few piles failing at the caps. The trouble has been overcome in the same manner as noted for the Beaumont division.

Air Seasoning of Untreated Sleepers.—Examination of the stringers in ballast deck bridges where steaming was done in treatment showed a condition similar to the piling, but it was not so extensive. In a very few cases we have found some of the outer stringers decayed on the upper surface, as a result of the irregular penetration of the creosote.

When we first commenced air seasoning material at Somerville untreated timber sleepers were used to support the piles of timber or piling. It was not very long before we discovered that these untreated timber sleepers were starting the growth of fungus or decay in the timber piles that rested on them, this decay frequently extending clear to the top of the pile of timber. We very soon found that we must use either creosoted timber sleepers, steel I-beams or concrete for supporting the piles of timber and piling, as this was the only means by which we could get the timber properly seasoned without causing decay.

Close attention is necessary in the air seasoning of timber piling. If the sap has commenced to turn or sour, the treating will not be effective. It is probable that different curing rules will be required in different section of the country where the moisture conditions differ.

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*[illegible]

Field Treatment of Piles.—As the result of our trouble from the rotting of piles at the caps we made an extended list on a field treatment of piles when cut for caps. With our first apparatus we were able to get about ⅜ in. end penetration of the creosote. Several first-class creosoted piles were cut into lengths of about three feet and also a similar number of untreated piles which were reasonably well seasoned. A part of these short creosoted specimens received the end treatment with our pressure apparatus. The other samples were painted with various kinds of preserving material and also several kinds of "R I W" paint. After the coatings had properly dried these short pieces of piling were set up in a trench in the ground on the right-of-way two miles east of Cleveland, Tex. These pile butts were set in an exact line and at the same elevation. A cap 12 in. wide and 4 in. thick was placed on top of the row of pile butts so that the test would be relatively the same as in the bent of a pile bridge.

We have examined these pile heads annually for 8 years. At present the samples of creosoted piles having pressure treatment on the ends and several of those receiving brush coatings on the ends are still in good condition. These investigations lead me to feel that a brush coating of hot, heavy, creosote, of Reeves Wood Preserver and Toch's "R I W" paint will protect the freshly cut heads of creosoted pile for a long time. I am not as yet certain whether it will be necessary to use the pressure treatment for the ends of piles, since the brush coating seems to be giving extremely good results thus far and the application of this brush coating will cost considerably less than the pressure treatment.

Rules for Handling Treated Timber.—Investigations made seem to show that the following rules must be adhered to absolutely in handling treated timbers:

1. Treated timber must not be cut, bruised or handled in a rough manner. Grab hooks or dogs should not be used in handling the material, unless the holes made by the hooks are carefully plugged with creosoted pins.

2. The driving of piles must be done with a hammer which will not split them or break the sap loose from the heartwood.

3. Any cut surfaces or bored holes must be carefully treated with hot creosote and the holes plugged.

4. Where solid stringers are used in ballast deck bridges without any cross planking it is necessary to make end cuts on some of the sticks on account of the variation in panel lengths of bridges due to driving of piles. These freshly cut ends must be thoroughly coated with creosote before the stringer deck is placed.

Standards for Ballasted Deck Pile Bridges.—In 1910 we made a new set of standard plans for ballasted deck pile bridges. In these plans the stringers were spaced 7 in. apart in the clear and lapped by one another on each second cap, cross planking being used to hold the ballast.

The stringers called for in these new plans were 7 in. by 16 in. 30 ft. and they had a working depth of 15¾ in. We soon found a sufficient supply of these 30-ft. stringers could not be obtained within reach of our lines in Texas and Louisiana, and as a result the plans were adopted for territories where we used only Oregon fir stringers. In open deck timber bridges the stringers and ties are untreated, but for some years past the ties on open deck steel bridges have been creosoted. The ties are always run through a surfacing machine and brought to exact depth.

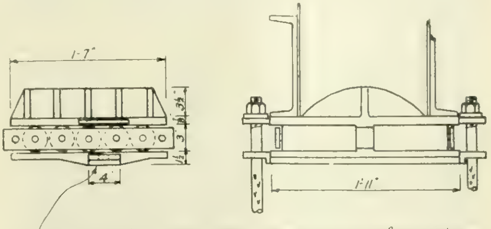
While Oregon fir loses a considerable percentage of its strength as a result of steaming or boiling during treatment, we have had no stringers break under traffic. Fir caps in bridges built under our old standard plans have, however, given some trouble. A good many fir caps are "boxed heart" pieces and our old ballast deck bridges had too many drift bolts through the stringers into the caps. The failures in caps were always in Oregon fir pieces. In almost every case of failed caps I found the timber was actually burned or charred in the boiling treatment and the sticks broken up into rings, much like the layers in an onion. Culling "boxed heart" pieces and holding the boiling temperature to a maximum of 220° F. very largely stopped the trouble with the fir caps.

Considerable timber has been used for the floors in ballast deck bridges. When we figure interest on the excess cost of the ballast deck over the open deck structure and also the cost of maintenance we can show a very interesting saving from the use of the bridges having the ballast decks.

An interesting feature of the ballast deck bridge is the very low maintenance cost. When the track has been thoroughly bedded and properly lined and surfaced almost no further expenditure is required during the life of the track tie. We have bridges about 100 ft. in length which we have run from three to seven years without receiving attention other than the lifting of a few joints at very rare intervals.

Roller Shoe for Girder Spans

An interesting detail of the recently completed Sixteen Mile Creek bridge near Oakville, Ont., the longest bridge on the Canadian Próvincial highway system, is the roller shoe used at the end of the girder spans. The super-structure of the bridge consists of a concrete floor carried upon eight spans of lattice trusses of 108 ft. 6 in. span, spaced 13 ft. 6 in. center to center, with 65 ft. span at the west end.



Masonry plate under rollers to bear only on 4" face until span receives its full dead load, thus permitting the shoe to adjust itself to the deflection of the span. Masonry plate then to be wedged up at the free ends and grouted under for full bearing

Detail of Shoe.

One end of each girder is fixed and the other end rests upon a nest of rollers. However, to provide against the possibility of the movement of the rollers being hindered by accumulated dirt, each pier is designed to resist the bending set up by temperature changes in the trusses. The resultant stresses and soil pressures in all cases are quite low. In the design of the fixed shoes and also in the sole plates under the roller rests, the deflection of the trusses under the heavy dead load was considered. As may be seen in the detail, reproduced from The Canadian Engineer, a strip of metal 4 in. long and the full width of the shoe projects downward from its lower surface. These strips bore directly on the piers, and after the full dead load was in place and full deflection had occurred, the remaining space under the shoes was filled with a strong mortar. Thus all danger of the shoe riding on its forward edge with the consequent possibility of spalling off the pier copings was obviated.

Tensile Properties of Structural Alloy Steels.—Technologic Paper No. 205, issued recently by the U. S. Bureau of Standards gives the results of a number of determinations of tensile strength, proportional limit, elongation, reduction of area, and strength at fracture throughout the range 20 to 500° C. for four steels containing about 0.38 per cent carbon as follows: (a) Plain carbon steel; (b) 3½ per cent nickel steel; (c) 3 per cent nickel and 1 per cent chromium steel, and (d) 1 per cent chromium 0.2 per cent vanadium steel. Brief reference is made to the types of fractures made in testing steels at various temperatures, and particular attention is paid to comparison of the tensile properties of these alloys at 550° C. Of the four steels tested in normalized condition, it appears that the two alloys containing chromium show greater resistance to weakening by increase in temperature to about 550° C. than either the plain carbon or 3½ per cent nickel steels, and at this high temperature the chromium vanadium steel is to be preferred from the standpoint of high tensile strength and limit of proportionality. The carbon and 3½ per cent nickel steels behaved alike with rise in temperature above that of the room and at about 550° C. the addition of 3½ per cent nickel appears to have but little effect upon the strength of the carbon steel. A copy of the paper can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 5 ct.

The Cleveland Thoroughfare Plan

A 24-page illustrated pamphlet bearing the above title and issued by the City Plan Commission of Cleveland, Ohio, contains an excellent general statement of a city planning project, the manner of approach to some of the various problems and the consequences of a policy of drifting or inaction. The text of the pamphlet follows with slight condensation.

The thoroughfare plan herewith submitted has been prepared by the advisers of the Commission, Robert H. Whitten and Frank R. Walker, tentatively approved by the Commission and is now presented to the public for its study and criticism.

Scope and Functions of the Plan.—The plan is intended to constitute a fairly complete system of traffic arteries for the area within the present limits of the City of Cleveland. The term thoroughfare as here used includes all streets that form the main framework of the general street plan. The thoroughfares collect the traffic of the local streets and carry it to all parts of the city. Local streets that are used chiefly for immediate access to the residences or industries of a small area are not included in the plan. Only about one-quarter of the 970 miles of streets in Cleveland are included in the present thoroughfare plan.

A careful study has been made of each thoroughfare with reference to its adequacy to handle present and probable future traffic and its relation to the complete thoroughfare plan. As a result specific recommendations and plans have been prepared showing where widenings should be made, where corners should be cut back, where over or under crossings should be constructed, and where extensions should be cut through.

Co-ordination of Recognized Needs.—The changes proposed by the plan are not new or original. They are for the most part changes that in the past seemed obvious and logical to the various individuals, civic associations and public officials who have from time to time considered these matters. Now, however, for the first time, they are sifted, assorted and brought together as parts of a complete and carefully co-ordinated plan. Presented in this way the importance of each to the general system is at once apparent.

Economic Limitations.—The plan submitted is by no means ideal. The area included is already largely built up and it seemed altogether impractical to proceed except with constant regard to the expense involved and the danger of creating burdens in excess of the economic benefits and in excess of the ability of the city to finance. The plan, however, will provide with reasonable adequacy for traffic needs for a considerable period of years. As compared with most other big cities, Cleveland's position as regards traffic conditions will be relatively advantageous. The plan, while far from ideal, constitutes a great improvement and its substantial achievement is well worth striving for.

Street Widening.—The plan provides for the widening of 98 thoroughfares having a length in the portions proposed to be widened of about 190 miles.

Existing thoroughfares have to a very large extent been opened and improved without regard to a general plan. This accounts for the frequent jogs in alignment, the lack of adequate connections and above all the entirely inadequate widths that are so general over the major portion of the city. Important traffic routes have been opened and improved apparently as purely local residence streets. Old country roads have been built up at their original widths of 66, 60, 50 or even 40 feet. Double track car lines have been placed in 50 foot streets with no provision for the widening of the street.

Street Cars and Street Widening.—A large proportion of the street railway trackage is located on streets and roadways of inadequate width. In order to provide reasonable freedom and speed both for street cars and for other traffic a roadway wide enough for one line of moving vehicles on either side of the car tracks in addition to space for vehicles standing at the curbs is absolutely essential. For this purpose a roadway width of 56 feet is needed. This with a sidewalk width of 15 feet gives a total street width of 86 feet.

The plan submitted proposes the eventual widening to a minimum width of 86 feet of most of the important thoroughfares and of practically all of the thoroughfares on which street railways now are or may be located. All such thoroughfares should be widened so as to provide for two lines of moving vehicles in each direction. Unless this is done, with the increase in traffic and the increase in the number of standing vehicles, the speed of all vehicles will be reduced to the speed of the slowest. Automobiles and street cars will be compelled to trail behind the slow moving horse drawn vehicles. A thoroughfare of that kind is very unsatisfactory for passenger automobiles, for street cars and for motor trucks.

The normal development for a car line street is retail business. Lorain Avenue is perhaps typical of the traffic and the kind of business development that will come to most of these thoroughfares. With business comes the increase in the number of vehicles standing at the curbs that makes it essential to have a clear central roadway width for two lines of moving vehicles in each direction. Unless this is done the speed of the street cars will be reduced to the speed of the slowest trucks, and automobiles will be compelled to trail behind the cars. Nothing could be more inimical to the future prosperity of the city than to permit these main arteries of traffic to be solidly built up at their present inadequate widths.

It is only by giving attention to the widening of many thoroughfares that the present high car speed outside of the center of congestion near the public square can be long maintained. Unless this is done street cars on many important arteries will be compelled to crawl along behind slow moving trucks. It will be impossible to keep the trucks off the tracks, because with the increase in the number of standing vehicles at the curb there will be no space in these narrow roadways other than the tracks in which the trucks can move. This will mean increased cost of street railway operation and increased fares and loss of time to the car riders. It will also mean continual interruption to automobile traffic and increased trucking costs.

Advantages of Set-Back Lines.—On many of the thoroughfares that are listed for eventual widening the buildings are at present set back from the street line. There is no urgent need for their immediate widening. The important thing is to insure that future buildings, stores or apartments shall be kept back from the present street line a sufficient distance to allow for a future widening. The widenings proposed would in many cases injure the use of the houses for residence purposes by cutting off the front lawns and bringing the houses too close to the street. The use of many of these streets will, however, gradually change from private dwellings to apartments or business buildings. When this time comes the street can be physically widened without injury to such apartment or business use. In the meantime, the fixing of a permanent building line back of the present street line will serve to protect the existing dwellings from serious depreciation owing to the possible erection of an apartment house on the present narrow street line and projecting out beyond the present dwellings. And when traffic has so increased that the street must be widened, it is more than likely that the street will no longer be desirable for private residence purposes and the private dwellings will have been replaced by apartments or by business buildings. Provision for future widening through the establishment of a set back line can therefore be made while the future traffic thoroughfare is still a residence street, with advantage to all owners, and when the time comes to actually widen the street to meet traffic needs this too will usually be to the advantage of the owners. By thus imposing the set back line and then widening the street at the very time that these things can be done with advantage both to the owners and the city, the widened thoroughfare can be secured at a minimum expense.

Many of the thoroughfares listed for widening are already in the transition stage. The former residences are being gradually replaced by apartments and stores. Most of the stores and some of the apartments are being placed out beyond the residences on the street line. Now is the time to stop this development before the exceptional example becomes the rule. Many of the structures already built out to the line are temporary wood buildings or taxpayers. In time they will be replaced and then if in the meantime other buildings have been kept back on the established line the street can be widened with comparatively slight expense.

Street Extensions.—Thirty-seven street extensions are proposed, having an aggregate length of 23 miles.

The street extensions will necessarily be more expensive than the widenings. Recommended extensions are therefore carefully limited to the connections deemed necessary to secure a fairly complete thoroughfare layout. In no section of the present city should thoroughfares be more than a half mile apart. Owing to existing building development, this minimum standard has not been attained in a few sections of the city. Wherever possible without too great cost existing streets have been connected by short extensions so as to form through routes. Many of these extensions if not provided for now will be cut through in later years at enormously increased expense.

Central Thoroughfares.—The central section of the city lying between Fulton Road on the west and E. 105th Street on the east and lying north of the valleys of Walworth Run, the Cuyahoga River and Kingsbury Run will embrace the principal business and community center of the Cleveland metropolitan area. The topography of the city is such that the bulk of the traffic to, from and through this business and community center must pass in a generally east and west direction. This section will therefore require all the increased east and west traffic capacity that it is now practical to secure.

In all large cities the demand is for more routes leading into and through the central business district. In Cleveland, the traffic difficulties are in large measure due to the reliance on a few main thoroughfares converging at or near the public square. The remedy lies in the provision of more thoroughfares of adequate width coming from the outskirts of the city into and through the central business section and out to the city boundaries on the opposite side. The central business section of the city should have an approximately rectangular layout, each street constituting the central portion of a main radial thoroughfare.

The street widenings and extensions proposed in this central section of the city will take care of the estimated increase in traffic for a period of thirty to fifty years.

Standard Thoroughfare Widths.—The following standard thoroughfare widths and cross sections are recommended:

	Street.	Roadway	Sidewalk.
Class A thoroughfare..............	66	40-42	13-12
Class B thoroughfare..............	86	55-56	15.5-15
Class C thoroughfare..............	100	60	20
Class D thoroughfare..............	120	76-80	22-20
Class E thoroughfare..............	140 and over		

The 66-ft. thoroughfare is undesirable unless traffic is light, unless the number of vehicles standing at the curb is negligible, unless there are no street car tracks, and unless the traffic using the thoroughfare is predominately either of the fast or the slow type. It will seldom be wise to apply the 66-ft. standard in laying out a city thoroughfare in as yet undeveloped territory. It is, however, a standard that it will frequently be expedient to apply in replanning the thoroughfare system of a built up area. In the plan submitted the 66-ft. standard is applied to a considerable number of narrow thoroughfares where the existing development seemed to make it inadvisable to attempt to secure a more adequate width.

The 86-ft. thoroughfare with a 56-ft. roadway provides for two lines of moving vehicles in each direction in addition to space for vehicles standing at the curbs. In the plan submitted the 86-ft. standard is applied to most of the routes recommended for widening or extension. It is the minimum width that seems at all adequate for any but minor thoroughfares. It should at least be a minimum for all main thoroughfares and for most street car routes and for all routes crossing the entire length or breadth of the future central business district.

It is recommended that the traffic ordinance be amended to require a special license for any vehicles in excess of 7.5 ft. in width.

Over and Under Crossings.—Various methods of separating grades at street intersections have been devised and a number have been actually applied. Where applied, however, it has usually been to meet exceptional demands of topography or traffic and not to solve the problem of a typical busy intersection. A separation of grades is comparatively simple if provided for at the time the streets are laid out and the grades established.

In the case of the typical busy intersection a complete separation of grades is not practicable. The intersecting routes cannot be completely separated as in the case of a steam railroad and a highway. Freedom of interchange of traffic between the two intersecting streets must be retained. The most that can be done is to carry the through traffic of one of the streets over or under the intersection. The intersection itself will still be complicated by the interchange traffic of both streets and by the pedestrian traffic of both streets.

In the extension of Carnegie Avenue it is recommended that an over-crossing be constructed to carry Carnegie Avenue through traffic over East 105th Street. Over-crossings are also recommended for eventual construction in Superior Avenue both at the East 30th Street and at the East 55th Street transfer points. The width of Superior Avenue (132 feet) and the comparatively undeveloped condition of the street frontage affected greatly simplifies the construction of over-crossings in these locations.

Speedways Must Be Planned in Advance.—In city railway transportation the elevated road and subway have not superseded the street surface railway but have merely supplemented it. The evolution of vehicular traffic may be somewhat similar. As traffic is slowed down and the average length of haul increases the problem of providing a number of high speed routes to carry traffic through the more congested areas will become very urgent. Unless such routes are planned long in advance of their actual need, they will be almost prohibitively expensive when at length they are imperatively required. Cleveland's topography is favorable to the development of a number of speedways radiating from the heart of the city. The River Valley and its branching ravines furnish possible locations for such routes. The Lake Front also may be used for this purpose. These possibilities should be further studied in connection with plans for terminal and rapid transit development and in connection with plans for Lake Front improvement.

A plan is submitted for the construction of a three mile speedway in the partially undeveloped area immediately north of Euclid Avenue between East 21st Street and East Boulevard.

The Traffic Problem.—Street traffic is increasing much more rapidly than population. If the growth of street traffic merely kept pace with the growth of population the problem of making adequate provision for the future would be sufficiently difficult. It is probable, however, that the street burden will under normal conditions increase twice as fast as population, i. e., while population is doubling the street traffic will be trebled.

The traffic problem is chiefly one of average speed and not of the number of vehicles it is physically possible to move through the streets. Even with all the interruption due to cross traffic there is abundant street capacity in so far as number of vehicles that it is possible to pass through the streets during any 2 or 12 hour period is concerned. All the traffic offering can doubtless be taken care of—the only question is with what delay and with what average speed. If an average speed of 2 to 6 miles an hour will suffice, there is no traffic problem now and possibly never will be. If on the other hand an average speed of 10 to 20 miles is demanded, the traffic problem is extremely urgent and difficult.

Extreme congestion means not only that street car service is disrupted but that all trucking and commercial traffic is slowed down. The cost of trucking is a much larger factor in the cost of most goods than is railroad freight. Many products are transferred by vehicle through city streets a half dozen times before they reach the consumer. If through street congestion, as is undoubtedly true in parts of Chicago, New York and London, the time and cost of trucking goods is doubled, the toll due to congestion is certainly enormous. It is paid in part by the public in higher prices. It also places a serious handicap on the commerce and industry of the city.

Method of Carrying Out the Plan.—The plan here proposed is not suggested for immediate application and construction in its entirety. The plan is intended rather as a twenty year improvement program. Most of the street extensions proposed should be made soon as there is no other way of preventing their being blocked by the erection of expensive buildings. The widenings, however, can for the most part be made gradually as and when new buildings are constructed or existing buildings are reconstructed. In this way the widened thoroughfare can eventually be secured (probable by the time it is imperatively needed) and the value of the existing buildings will be saved.

It is proposed that the plan shall be submitted to the city council for approval as the official thoroughfare plan of the city.

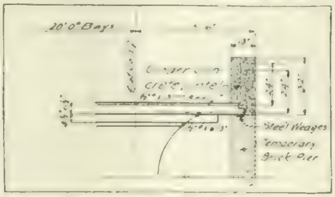
The cost of carrying out the plan is dependent on various factors not clearly ascertainable at the present time. The cost, however, will in all probability be not less than $20,000,000 not including the cost of the proposed bridges across the Cuyahoga Valley. A financial program authorizing the expenditure of from one to two millions annually should be adopted in order that the most urgent features of the plan may be carried out and the erection of any buildings that would seriously interfere with the eventual carrying out of the plan prevented.

The Cost of Delay. Chicago is now spending more than [illegible] in the widening, extension and improvement of a few main thoroughfares. Most of this expense would have been saved if Chicago had, when it was the size that Cleveland now is, prepared and consistently adhered to a thoroughfare plan. Cleveland in a few years will be compelled to expend similar amounts for improvements that can now be provided for at comparatively trifling cost.

There is nothing quite so permanent and difficult to change materially as a city's streets after they have once been solidly built up with business buildings or apartment houses. Buildings have come and gone but the streets of central Boston and lower Manhattan retain most of their original crooks and turns. On many of the streets included in the proposed thoroughfare plan for eventual widening, the buildings are for the most part set back from the street line. Now is the time to provide either for the immediate widening of these thoroughfares or for their eventual widening as and when new buildings are constructed or the present residences are replaced by store and apartment houses. Cleveland is building up and spreading out so rapidly that every year's delay in the adoption and enforcement of a thoroughfare plan will mean an enormous loss to the future city both in money outlay and in commercial and industrial efficiency.

Method of Providing for Future Extension of a Building

An interesting detail of the 3-story flat slab building now being erected at Kensington avenue and M street, Philadelphia, by William Steele & Sons Co., contractors, is the method of providing for the future extension of one side of the building. To prevent the reinforcing steel from projecting and thus being exposed to the elements until the future connection is made, a cinder concrete lintel, a detail of which is shown in the illustration, is provided into which the rods are bent upward. The brick piers are temporary also, and when the future connection is made these piers, as well as the cinder lintel, come out. The temporary wall and lintel are placed at a distance of 5 ft. 6 in. from the center line of columns, this being the point of inflection or zero moment. When the lintel is knocked out the rods are bent back into correct position in place for the future floor slab, and the normal bay length of 20 ft. is secured. The cinder concrete lintel serves two purposes. It prevents the rods from rusting and has sufficient depth to carry the steel which depth gives it the needed strength. During the period in which the wall is temporary, steel wedges resting on top of the brick piers are wedged so as to force the piers to carry part of the floor load. We are indebted to Successful Methods for the above notes.



Detail of Cinder Concrete Lintel.

Selling Engineering Service*

By PAUL E. GREEN,

Consulting Engineer, Chicago

There can be no question but that most of a consulting engineer's success is due to his ability to sell his services and in that way he is just as surely a salesman as is the man who is selling shoestrings or any other commodity by direct solicitation. My own experience in selling has not been so broad that I can qualify as an expert sales manager. I can only give my personal experience with the hope that other members of this organization will be equally frank in telling theirs and in this way we may all learn something of value.

Usually one or more men decide to enter upon private practice after they have been employed by other corporations, or engineering firms, and have had a considerable number of years of experience in the design and construction of engineering work. Probably one or two friends get together and decide that they can make a lot more money by practicing their profession privately. Quite frequently they have no experience in selling their services and have inadequate capital. However, they are very optimistic. They tell their friends they are going to organize a firm and their friends promise them their work. They feel that $500 is sufficient capital and before that is spent they will have enough work to keep them going. An office is rented, possibly they have a few engineering instruments and they are ready to start. Their awakening is rather abrupt. They usually find that within a few weeks they have accumulated no paying work and their capital is gone. They don't know how to get work. They find that very little work flows into the office voluntarily and they immediately begin to cast around to remedy this condition. Unless they are well supplied with money it will be necessary to radically reduce their expenditures for living but if they have the real stuff in them they now begin to get down to brass tacks and make a direct assault upon these sources that can use a consulting engineer. It is my opinion that a two man firm needs a cash capital of not less than $15,000 to handle $25,000 to $30,000 of professional work per year.

Sources from Which Work May Be Obtained.—There are several sources through which professional work may be secured. These may be classified as follows:

A.—From other engineers.

B.—From municipal, state, county and other political subdivisions.

C.—From private corporations.

D.—From individuals who may have need to employ engineers from time to time.

Probably the most prolific, certainly the most easily attacked one of this group is the municipal sub-divisions.

From other engineers work is secured because of a good reputation with that engineer so that when he needs the services of a specialist he will turn to the man who has such services for sale. This is a most satisfactory way in which to receive work. It only comes from extensive acquaintance with other engineers through years of service. This acquaintanceship is secured by joining technical societies and taking some active part in them; by contributing technical articles to the press on the specialties with which the engineer is best acquainted, and by personal acquaintance, socially or through common employment. I find as the years go on that this class of work is slowly but constantly increasing and I think this is the experience of other engineers. It can only be secured because the seller is, in the opinion of these employing engineers, a particularly good man in his field, in other words, he has sold his services to this particular engineer, not by means of propaganda, but through a long period of association.

Securing Work from Municipalities.—The municipalities, which are probably the most prolific source of work, are approached in various ways. Small or large ones seem to have little difference in their methods. Even in the large city the city engineer often has little to say as to what consulting engineer is to be employed. The consulting engineer is employed by a council committee or by lay commission which has a particular work to do and quite frequently this work is secured by direct solicitation.

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*Paper presented at a conference of Practicing Engineers held Feb. 12 at Chicago under the auspices of the American Association of Congress.

It is one of the handicaps against which we all work that even a prominent engineer is prominent only to his fellow engineer and often is unknown to the public. However, the fact that he has been active in a technical society, has contributed to the technical press and is well known to the fellow men of his profession is a strong recommendation and a considerable help to him in securing work, but I question whether it is not necessary in two cases out of three for the firm and individual to solicit directly even large cities. Certainly it is true with the smaller municipalities.

Mail Campaign for Clients.—Probably one of the first things that a new firm does when it is organized is to circulate prospective clients. Since I am more familiar with the municipal field than any other, these observations of necessity must apply more directly to that field. Circular letters and similar advertising appeals are sent out by the thousands by various engineers. Practically every mayor and city clerk in the country receives dozens of them each year. In spite of the fact that this method of looking for tips is very common and extensive there are considerable results from these efforts. The percentage of replies is very small; we found that circular letters sent out in 2,000 and 3,000 lots brought less than ½ of 1 per cent of replies. When accompanied by self-addressed envelopes and in normal times, the replies were about 10 per cent, of which 90 per cent was returned with the remark that there was nothing doing. However, some direct results are obtainable from these letters, and it is an important method of securing advance tips on work. It is not inexpensive.

We have from time to time tried clipping bureaus, advance reports and similar methods in an endeavor to get information as to prospective work, but we have always found that they did not pay for their cost. The reason has been that invariably by the time the items were sent to the bureaus they were too late for the engineer, though all right for the contractor. But as real advance information for the engineer it is generally too late. In fact, most of it comes from the engineers who are already engaged in the preparation of the reports or plans.

We have also used the professional card extensively, and while there is an occasional inquiry because of this card I doubt very much if as an advertising medium for a prospective client or as a method of securing work it is worth anything. When an inquiry does come from this source, it has usually been sent to a dozen firms. It does, however, keep your name before other engineers and we believe generally speaking that this is about all it does do. It lets them know that you are not dead.

Technical Articles as a Means of Reaching Prospective Clients.—We believe that one of the most valuable means of reaching the prospective client, both officials of a city or employing concerns, is by means of articles contributed to the technical press. You get paid for these articles, they make your name known to other engineers and occasionally a city official will see them. If he needs services of this kind he quite likely will write to the author and this means that there is practically no competition. The lightning does not strike very often, but when it does strike it generally leads to a very profitable transaction.

Referring to the third source of technical work, that is, private corporations, this is a highly desirable field and often requires solicitation, though not to the same extent or of the same character as is required with municipalities. Once secured as a client, the corporation seldom looks elsewhere. It is, however, more difficult to get advance information from private corporations and much of the work given out from private corporations is like that given out by engineers, the result of acquaintanceship and technical reputation. As a whole it is very desirable work.

Private individuals from time to time also have considerable work to do, but not much of this work can be secured by solicitation. It, like that from other engineers, comes largely because of acquaintanceship. This acquaintanceship may be accomplished by belonging to societies, organizations, clubs, and by general activity in civic affairs through which publicity is secured. We have found that a considerable amount of this work is secured through the friendship of the higher class of contracting supply men who may belong to clubs, for instance, and if they do, are liable to be active in the affairs of that club.

No tip should be ignored; nine times out of ten the tip is worthless, but the tenth time it may be very much worth while. These tips come to an office from material men, contractors, salesmen who desire to curry favor in this manner, and from a thousand other sources. Quite frequently the same tip has been handed out to a dozen firms, but once in a while it is a genuine tip, and for this reason it should not be ignored.

Former Employees as Source of Work.—There is another source of work which is quite valuable as the age of a firm grows. It has had various employees who have come and gone. Frequently they have gone because the firm could not make it worth their while to stay, and if they have departed in good spirit, with the best of feelings, and have a healthy respect for the firm, they are a valuable source of information. This is a particularly gratifying method of having work come to an office, but illustrates the fact that a successful organization is successful partly because it treats its employees in the highest and best manner.

One of the most important parts of selling engineering services is the character of work the company performs.

I would judge that at least 50 per cent and possibly more of the firm's clients will have additional work to do after a season or two. Of course, in the municipal field this does not mean that the old firm will be re-engaged; in fact, it may mean quite the contrary, but if your work is well and conscientiously done, in a great many cases when the time comes around for additional work you will get it without competition, and if friendly relations are maintained with the municipal officials they frequently will tip you off to other work in other political subdivisions or in adjoining municipalities. Because of the idiosyncrasies of some city councils, their tendencies to critcize for political reasons, it is sometimes pretty hard to follow this program out in its entirety. I personally have lost a large amount of work because I was foolish enough to call the chairman of a finance committee a liar. The fact that he was a liar had nothing whatever to do with the case. This municipality has done a large amount of work since I finished with them, but I have done none of it. But the lesson has been well learned.

One source of professional work which should not be ignored is that resulting from the activities of various state departments. These departments in themselves have from time to time employment for the consulting engineer along such lines as water supply, highway and paving work, sewage disposal, drainage and hydraulic developments. They also, because of their activities, recommend considerable work of this kind to other political subdivisions of the state. By keeping in touch with these departments a line is frequently had on prospective work which can be followed up with success. There is of course the possibility that such activity may be abused. We have all heard of such abuse from time to time, but much of this reported abuse is, I think, rather exaggerated. It is certainly legitimate to keep in close contact with these sources of information. The illegitimate part of it comes in when officers and employees of the political subdivision use their offices and information for personal gain.

General Public Not Familiar with "Engineer."—One difficulty which the engineer in private practice meets is the general confusion in the public mind as to what the word "engineer" means. Very frequently the layman considers that an engineer is a builder or contractor. The same confusion does not exist with the word "architect," with the result that when a prospective client wants a large building he instinctively goes to an architect first. It very frequently happens, however, in engineering work that a prospect goes to a contracting firm or material man instead of going directly to the engineer who may design such work.

It would seem as if a campaign to educate the public along this line would tend to largely increase the field for the practicing engineer, and that in this way the practice of manufacturing or contracting organizations of making plans and designing work, which is inevitably to their own individual advantage, might be counteracted.

Close Personal Contact Important.—No campaign for professional work will be of any great benefit to the firm if it is not followed up by close personal contact. Tips may be had but mighty little work is secured from these tips unless they are actively followed up. Very little work, indeed, which is not the result of recommendation by another engineer or another client, can be secured purely through correspondence.

I lay this down as an absolutely fundamental principle based on the result of quite a few years of experience.

In the private practice of engineering there enters from time to time the unexpected employer. Under this may be classified the attorney who wishes expert service for court work, the promoter who wishes to develop some idea along engineering lines, the fellow club member who suddenly is confronted by a problem of an engineering kind and turns to his engineering friend. Most of these come without solicitation and as a result of personal contact which had nothing to do with engineering work. And yet these as sources of work increase as years go on and it has been impressed upon me that much of it comes from a genial and pleasant interest in the other man's affairs. It is a very valuable field and no rules can be laid down for its cultivation, but it is a strong asset of the individual practitioner.

A final source of employment, not unimportant, is that which may be developed through political activity in its better sense. Engineers have not done much of this, but other professional men have with an increase in prestige. In my opinion it would be much better for us if we did take an active personal interest in politics, not merely as an aloof critic, but as a member of a party organization, openly interested in party success.

The Engineer and Public Service*

By JOHN H. DUNLAP,

Professor of Hydraulics and Sanitary Engineering, State University of Iowa

The engineer's world, the mechanical world, presents quite a new set of problems for national, state and local governments to ponder, and attempt to solve. For instance, Senator King, one of the speakers at the annual dinner of the Society of Engineers of Washington, D. C., on Dec. 7, 1921, is reported to have said that the country would be benefited if the existing United States Senate should resign, and each place be filled with an engineer. The Bulletin of the Federated American Engineering Societies has surprised us with its long lists of the bills introduced in congress which are of direct interest to engineers. Moreover, our state legislatures and our local councils all over the land are dealing more and more with matters with which engineers are more familiar than is any other class of technically trained men. Notwithstanding this fact, the engineers who are rendering public service of this character, are so few in number as to be almost negligible.

Old Methods of Government Should Receive Scientific Study.—Furthermore, it is high time that not only the new problems, but also the old methods of government should receive scientific study. It is most interesting to note that the city of Cleveland, which is our fifth city in point of population, has recently voted in favor of the city manager plan, and has also reformed its method of electing its city council. The new plan provides for proportional representation. By proportional representation the disfranchisement of minorities is prevented. For instance, by the common method of representation in our country, the man who votes consistently a democratic state ticket in the state of Vermont is practically permanently disenfranchised. Of course proportional representation is already in use in many parts of the English speaking world. Its applicability to American conditions has already been demonstrated in the election of the city council in 1920 in Sacramento, California. It needs only intelligent study to gain friends everywhere and wide acceptance at elections.

Engineers Who Have Caught Vision of Public Service.—Fortunately some engineers have caught the vision of the public service which men of our profession are equipped to render, and are in themselves the personification of all we have been trying to say. For example, Charles P. Steinmetz is one of America's most distinguished electrical engineers. He has been, since 1893, the consulting engineer of the General Electric Co., and since 1902 professor of electrophysics at Union College. He is the author of many technical papers and books, which are perhaps the most outstanding in their class. He is a past-president of the American Institute of Electrical Engineers, of the Illuminating Engineering Society, and of the National Association of Corporation Schools. But in addition to everything also he is giving in public service generously of his trained ability. He has been president of the Board of Education of Schenectady since 1912, and president of the Common Council since 1916. He has also published a volume entitled, America and the New Epoch.

One other illustration must suffice. Herbert Hoover is said to be one of the few really great mining engineers of his generation. In the practice of his profession he has accumulated what seems a tidy fortune for an engineer. Moreover, he is a past-president of the American Society of Mining and Metallurgical Engineers and has written a book, "The Principles of Mining." Is it not significant, however, that the trained genius of Mr. Hoover, the engineer, saved more than once whole civilian populations during the late war from starvation, and in so doing put living steel into the soul of the battle lines? And now, as Secretary of Commerce, Mr. Hoover is grappling with the problems of the new world, an engineer using the methods of applied science in the study and in the solution of our industrial problems.

How the Average Engineer Can Help in Public Affairs.—Examples like those of Steinmetz and Hoover naturally raise this question: How can the average, garden variety, sort of engineer bring his training in applied science to bear upon the solution of the problems of the new era, for which he is so largely responsible? In Iowa the way is easy. In our principal cities our district clubs of engineers are meeting regularly and taking active interest in municipal affairs. These clubs are component parts of a strong state organization, which serves as a clearing house for the activities of the clubs and seeks to render to the state the service for which the engineer is qualified. Moreover, our state organization is a member of the Federated American Engineering Societies. This is a comprehensive organization dedicated to the service of the community, the state and nation. In taking our part in public affairs, however, no engineer should think of his own selfish interest or reward. Each one of us should undertake to assist in the solution of at least one community problem, and give to it the best that is in him. In case the general public finds our service of value, whatever reward is attached to valuable service will naturally be ours. But the service must be first.

One plain duty of everyone is to initiate a plan, not for China or Africa, but for the place where he lives, which will gradually bring to pass a more intelligent and a more consecrated citizenship. As Theodore Roosevelt has said, the members of our communities should be graded not according to color, race, creed, wealth, education, family, but according to their performance of the duties of citizenship. To this end your attention is called to the suggestive booklet entitled, A Plan for Unified Community Effort in American Citizenship, by Martin J. Wade, Judge of the United States District Court. In brief, Judge Wade suggests a community council, representative of all patriotic and fraternal societies and clubs of the community, to meet at least monthly. Such a council could lay out a comprehensive program for a community and transform it in a generation into the best possible place in which to live, to build homes, and rear children.

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*From presidential address at 34th annual meeting of Iowa Engineering Society, Sioux City, Ia., Jan. 17-19.

Prices of Portland Cement in 1921

Preliminary estimates made by the United States Geological Survey from reports of representative producers of portland cement show that the average factory price per barrel of portland cement excluding cost of container in the United States in 1921 was approximately $1.87.

The prices by districts were as follows.

District.	Average factory price per barrel in 1921.
Eastern Pennsylvania and New Jersey	$1.72
New York	1.90
Michigan and northeastern Indiana	1.85
Illinois and remainder of Indiana	1.68
Western Pennsylvania and Ohio	1.73
Maryland, Kentucky, Virginia and West Virginia	1.83
Alabama, Tennessee and Georgia	1.94
Iowa, Minnesota and Missouri	1.77
Kansas, Nebraska, Oklahoma and Texas	2.15
Colorado and Utah	2.33
California	2.35
Washington, Montana and Oregon	2.51

The average net factory price received per barrel for the whole country in 1920, as shown by reports received from all producers, was $2.02.

Distribution of Income*

Society the world over is in a state of disorganization and confusion. Millions of workers are without employment or regular income, and their dependent families are in distress. In the United States the crops and foodstuffs have been ample, but the producers are unable to dispose of them at remunerative prices because the would-be consumers are unable to buy. That this state of affairs is deplorable all are agreed. Nobody desires it to continue, but there is lack of agreement as to what may be done to remedy the situation.

There is a prevalent opinion that some authority or group of leaders might set everything right if only it was impressed with the necessity for doing so. This bank receives letters, evidently written in all sincerity, urging that the great banks take speedy steps to afford relief. The banks are as much interested in the revival of prosperity as anybody can be, but have no control over the situation. The Government at Washington is urged from many quarters to do something forthwith, but the officials of the Government have enough to do to make its own financial ends meet. The Government has no control over the fundamental factors in the present situation.

Prosperity is a state which exists when everybody is able to readily exchange his labor or products for the labor or products of others. The terms of those exchanges have to be agreed upon by the immediate parties to them. Neither the Government nor the bankers can say how many bushels of corn shall exchange for a pair of shoes, a suit of clothes or a ton of coal, and these exchanges are the seat of this present disorder. When it suddenly takes two or three times as many bushels of corn to buy shoes or clothing, stagnation in the shoe and clothing industries naturally results. The purchasing power of the corn-growers is curtailed.

Industrial Discontent.—The explanation of the disorder which exists in industry is largely in the state of mind of the workers. It cannot be doubted that as a result of agitation that has been going on for years the wage-earning population has become to some extent imbued with the idea that wage-earners have been unfairly dealt with by the employing class. Many of them believe that they have not received a fair share of the fruits of their labors, and have determined to do less work and get more for it. One natural effect of this belief is to reduce the efficiency of the individual worker. Of course no one will work with good heart if he thinks he is unfairly dealt with. Another effect is a want of harmony between organized labor and the employers which interferes with the effective direction and management of industry. Of what use is it to appeal to bankers or employers for remedies for unemployment when their opinions and advice are viewed with suspicion and they can do nothing without co-operation?

What is the truth about the division of the industrial product? Do employers as a class obtain an excessive and unfair share of it and the wage-earners as a rule less than they ought to have? Is the distribution an arbitrary one, determined by employers to suit themselves, or is it a varying one, determined by industrial conditions and economic law?

Numerous calculations have been made from time to time by statisticians from the available data, and the data is increasing from year to year as statistical reports upon production are extended and made more complete. The income reports required by the government in connection with its system of taxation have added much to available material.

Who Gets the Industrial Product?—Evidently it is highly desirable that a careful study of the distribution of current wealth shall be made. What becomes of the industrial output of the country? For whose benefit does this great industrial organization function? In whose service are the thousands of factories running and the railroads kept in operation? For whose ultimate benefit are the great sums of capital raised, as represented by the daily bond and stock flotations, and the great industrial works projected? Do a few owners reap the benefits or are they widely diffused?

And not only is it very desirable that the truth shall be ascertained about distribution, but important that it shall be determined by the co-operative studies of a group of men representing different views upon social and industrial questions. In other words, it is highly desirable to have the facts removed from controversy. It is not to be supposed that men will ever agree in their opinions about all social and industrial policies, but if they can agree upon certain facts, much that is in controversy may be cleared up.

The National Bureau of Economic Research, Inc.—For the purpose of creating an organization for economic investigation whose findings would be generally accepted as trustworthy the "**National Bureau of Economic Research, Inc.,**" was organized in New York in 1920. The original Board of Directors was made up as follows:

Professor Thomas S. Adams, Department of Economics, Yale University, Tax Adviser to the Treasury Department.
Professor John R. Commons, Department of Economics, University of Wisconsin
John P. Frey, editor of the International Moulders' Journal.
Edwin F. Gay, editor of New York Evening Post, formerly head of the School of Commerce, Harvard University.
Harry W. Laidler, secretary of the Intercollegiate Socialistic Society.
Ellwood Mead, professor of Rural Institutions, University of California.
Professor Wesley Clair Mitchell, Department of Economics, Columbia University.
J. E. Sterrett, of Price, Waterhouse & Co., public accountants, New York.
N. I. Stone, statistician and labor manager Hickey-Freeman Company, Rochester, N. Y.
Professor Allyn A. Young, Department of Economics, Harvard University.

The organization was formed with the above Board of Directors and vacancies in these memberships are filled by the Board itself.

In order to make the management and supervision still more representative, the following organizations were invited to each name an additional member of the Board, with full powers, and pursuant to this invitation the parties named were chosen and have participated in the deliberations of the Board:

American Economic Association—Professor David Friday, of the University of Michigan.
American Federation of Farm Bureaus—Gray Silver, Washington, D. C.
American Federation of Labor—Hugh Frayne, New York.
Engineering Council—W. R. Ingalls, New York.
American Bankers' Association—George E. Roberts, New York.
American Statistical Association—Malcolm C. Rorty.
Periodical Publishers' Association—A. W. Shaw, Chicago.
Industrial Relations Association of America—J. M. Larkin.
National Industrial Conference Board—Frederick P. Fish.

The research work was placed in charge of four men, eminently qualified by education and technical experience, to wit: Wesley C. Mitchell, Willford I. King, Frederick R. Macaulay and Oswald W. Knauth.

Distribution of Current Income.—It was determined that the first study should be into the distribution of the current incomes of the people of the United States.† The subject was approached from two sides, by statisticians working independently, on the one hand from data relative to the production of wealth in the country, such as statistics of the crops, mineral products, transportation, etc., and on the other hand from data relative to incomes received, such as income tax returns, census reports of salaries and wages paid in the industries, etc. A vast amount of information of various kinds is available, much of it fragmentary but valuable as affording opportunities for cross-checking. The two calculations from different sides of the subject check each other so well that for the nine years from 1910 to 1918 the average annual aggregate income of the people of the United States is fixed at $40,200,000,000 by one method and $39,700,000,000 by the other method. There are uncertain elements in the calculation, but the investigators agree in the opinion that an allowance of 10 per cent for error in the main findings is ample.

The National Income at 1913 Prices.—One of the most interesting features of the calculation is the table showing the aggregate national income yearly from 1910 through the war period and also the purchasing value of that income translated into 1913 values. Calculated in dollars the national income increased from $31,300,000,000 in 1910 to $66,000,000,-

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*From the Bulletin of the National City Bank of New York.

†Income in the United States, by National Bureau of Economic Research, published by Harcourt, Brace & Co., Inc., No. 1 West 47th street, N. Y.

000 in 1919, but calculating the value of the national product at 1913 prices the figures for 1919 are only $37,300,000,000, showing that the actual gain in product was only about 20 per cent which is not much more than normal growth for nine years. The figures for each of the years are as follows.

Year	National income (billion dollars)	Weighted index number of prices	Purchasing power at price level of 1913 (billion dollars)
1909	31.1	[illegible]	[illegible]
1910	31.2	[illegible]	[illegible]
[illegible]	32.4	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	40.1
[illegible]	53.9	[illegible]	[illegible]
[illegible]	61.7	[illegible]	38.4
1919	66.0	[illegible]	[illegible]

The final estimate of the average income per capita, and purchasing power at price level of 1913, for the years from 1909 to 1918 is as follows.

Year	Population in millions	National Income in billion dollars	Income Per capita income in dollars	Purchasing power at price level of 1913. Income in billion dollars.	Purchasing power at price level of 1913. Per capita income in dollars.
1909	90.37	$28.8	$319	$30.1	$333
1910	92.23	31.4	341	32.2	349
1911	93.81	31.2	[illegible]	31.7	338
1912	95.34	33.0	346	33.2	348
1913	97.28	34.4	354	34.4	354
1914	99.19	33.2	335	33.0	333
1915	100.43	36.0	358	35.2	350
1916	101.72	45.4	446	40.7	400
1917	103.06	53.9	523	40.8	396
1918	104.18	61.0	586	38.8	372

The per capita income shows what would come to each person if all incomes were lumped together and the sum divided equally to the population of the country.

Division Between Employes and Owners.—One of the most **interesting results, and one which throws a flood of light upon the vexed wage question, is given in Table 18. This shows the "division of combined net value product of mines, factories and land transportation between earnings of em**ployes and returns for management and the use of property." **The results are given in millions of dollars and also in per**centages of the net value of the product, as follows:

Year	Millions of dollars: Wages and salaries	Millions of dollars: Management and property	Per cent: Wages and salaries.	Per cent: Management and property
1909	$6,457	$2,960	$68.7	31.3
1910	7,156	3,2[illegible]	68.8	31.2
1911	7,2[illegible]	2,791	72.3	27.7
1912	[illegible]	3,163	71.6	28.4
1913	8,631	3,359	72.0	28.0
1914	7,947	2,816	73.8	26.2
1915	8,722	3,470	71.5	28.5
1916	11,650	5,810	66.7	33.3
1917	14,3[illegible]	6,502	68.9	31.1
1918	14,472	[illegible]	77.3	22.7

Note: In this table "wages and salaries" includes pensions, compensation for accidents, etc.; "management and property" includes rentals, royalties, interest and dividends.

The above table includes the large, highly-organized industries, which according to the report, roughly speaking, **produce one-third of the national income.**

Commenting upon the showing the report says:

> Except in farming and government work, which present obvious peculiarities, the percentage of the net product going to employes [illegible] 1913 and 1916 and [illegible], between 1916 and 1918 [illegible]. The rapid rise of prices in the first period [illegible] immediately to the benefit of profit makers. **Wages** [illegible] behind prices in their rise, but they began to rise rapidly and the number of [illegible] employed increased largely after the [illegible] had slowed down. The net result was that by 1918 [illegible] were getting as large a share of the product as before the war, and in some cases a decidedly larger share.

Another significant comment is as follows:

> [illegible] data comes from [illegible] suffer presumably [illegible] profits. But the [illegible] of enterprises that go [illegible] are not likely [illegible] full reports, though [illegible] "management and property." We do not [illegible] make an ap[illegible] business men and [illegible]

Of the division between wages and salaries, the report says:

> [illegible] are that in highly organized enterprises [illegible] per cent of the pay roll [illegible] per cent of the net value product. It [illegible] that wages but fall [illegible] at all in hard times. The net increase from 1909 to 1918 was 1[illegible] per cent in salaries of officials as against 172 per cent in wages of manual and clerical employes.

A Conclusive Showing.—**Here is definite information, well** authenticated, as to the division of the industrial products, at least so far as the highly organized industries in which large capital and great numbers of wage-earners are employed. It shows that in the ten years under examination **wages and salaries absorbed from 66.7 to 77.3 per cent of** the total values produced in these industries, the remainder going to the owners and others supplying capital. This, as the report properly points out, is the showing for the going industries; it does not include industries which have failed, shut down and made no reports of operations. A complete showing of the net return for capital in all industries would require that these losses be included.

Of course the share of capital as shown, ranging from 22.7 to 33.3 and averaging for the ten years 28.8, did not all go to rich people. The stocks and bonds of corporations are a **common form of investment for people of all classes, and the bonds are very largely held by savings banks and life** insurance companies. Moreover, an important share of the net earnings of the industries is devoted by the owners to enlarging the industries and improving the equipment, which redounds to the benefit of the public even more than to their own advantage

These figures are something to ponder over. They ought to be brought to the attention of everybody, and particularly of those who are disposed to be critical of the existing **industrial order. How much more than 70 per cent of the industrial product can the employes reasonably claim for** their services, as against management and invested capital? Some accumulations there must be for the enlargement and **betterment of industry, and some compensation for accumulation and for the responsibilities and risks of ownership are necessary in the common interest. The wage-earners are invited to participate in ownership, and where they take** this invitation seriously are soon able to obtain an important **share in it.**

The "Cost of Living" Theory of Wage-Fixing. The Executive Council of the American Federation of Labor in a statement recently given out has declared against the practice of fixing wages with relation to the "cost of living." "The **American trade union movement," said the declaration, "believes that the lives of the working people should be made better with each passing day and year. The practice of** fixing wages solely on a basis of the cost of living is a vio**lation of sound economy and is utterly without logic or sci**entific support of any kind."

The practice referred to developed during the war when great confusion existed in wages and prices and there seemed to be no better way of temporarily adjusting wages than by reference to the changes in the cost of the principal necessaries. Claims for wage advances were usually based on **the advancing cost of living, and the validity of the argument was accepted.**

It is true that the practice is unscientific and unsound, for the theory upon which it is based runs in a circle, the cost of living being itself determined mainly by wages. It should be added that all arbitrary or purely theoretical standards **of wages and of living conditions are unscientific and un**sound, except as they may be offered as ideals to be striven for. It is useless to set up an ideal standard of living in Russia at this time; if the food has not been produced it is not to be had, and living conditions everywhere depend at last upon the volume of production. The tables given above show the aggregate income of the people of this country, which it may be observed is somewhat in excess of the aggregate production of wealth, as a good many incomes included are for services which figure as production in a negative way such as most government services. It is impossible to divide any more than all there is; there is a definite limit, and the total is not ample. The lives of the working people will be made better if production is increased, not otherwise. It is important to put the emphasis in the right place. Endless gains are possible by that means, but few may be expected by fighting over the three-tenths of one-quarter that now goes to management and capital. Harmonious industry will increase them, but group warfare will diminish them

Distribution Governed by Economic Law. The lesson to be found in this study of incomes is that they are governed by economic law, and not, as commonly assumed, by arbitrary power. They are not, in any general sense, within the control of employers, either singly or as a body, to fix as they please; nor can the general wage-level be materially changed by organization among wage-earners. There are certain relationships throughout industry, which in the long run are bound to be maintained. There is a balance, or equilibrium, which must be maintained for the best interests of all; if it is disturbed, the normal exchange of goods and services is interrupted, and although wages may be nominally high they are actually low when unemployment and the cost of living are taken into account. The latter is the state of things existing today.

The situation tends under the free play of natural forces to make the necessary adjustments and come into balance. The products and services which all classes have for exchange must be so valued to each other that the exchanges can be made. Wages must be high enough to enable the wage-earning class to buy and consume their normal share of the industrial product; otherwise products will accumulate and business will be bad. Likewise farm products must have a purchasing power compared with other things that will allow the great body of people who live on the farms to take their usual share of goods, or unemployment in the other industries will result. Thus, every class, instead of being interested in fixing its own compensation without regard to the effect upon others, is interested in that right adjustment of values which enables the exchanges to be completely made, and in that manner serves the common interest.

When this idea of the necessary balance throughout industry is fully understood, the costly controversies and trials of strength, the "blocs" and various devices for imposing the will of small groups upon the community, will be seen to have been wholly misconceived and ineffective.

The Way of Real Progress.—The way of real progress is not by petty efforts to "make work" or advance the interests of each group at the expense of the others, for these have the net result of nullifying each other and obstructing all progress, but by the improvement of methods, making labor more effective everywhere, thus bringing more of the comforts of life within the reach of everybody. Every individual, whether he be employer or employee, who does not lend his efforts in good faith to accomplish this end is unfaithful to his social obligations.

When it is realized that seven-tenths to three-fourths of the industrial product goes direct for personal services, it will be appreciated how great are the gains to labor from industrial progress. Every invention, every installation, every investment of capital that increases the industrial output increases the income of labor by approximately three-quarters of the amount.

Conversely, every scheme for reducing the efficiency of labor or compelling the unnecessary employment of labor, thereby increasing industrial costs, offsets and nullifies the achievements of inventors and industrial leaders, and slows down the rate of social progress.

Engineering Achievement.—An eminent engineer, Mr. John E. Zimmerman, in an address delivered last month at a dinner of the Engineers' Club of Philadelphia, made the following illuminating statement as to the benefits that are accruing from improvements in the use of steam power since the Centennial Exposition was held in 1876.

> Contrast often tells a story: the great Corliss Engine exhibited at the Centennial Exposition at Philadelphia was of the then unprecedented capacity of 1,400 H. P. and rotated at 36 R. P. M. Contrast with this the present largest turbo-generator of 80,000 H. P. (60,000 K. W.) at 1,800 R. P. M. What this advance and progress in the science of generation of electricity alone has meant to the human race in the conservation of its natural resources can best be illustrated by the amount of coal which would have to be burned today to produce the demand for central station energy if it had to be generated by the type of Colossus Corliss exhibited at the Centennial Exposition. I figure conservatively that the saving effected in a year's time, in this respect alone, amounts to not less than 21,000,000 tons, which if taken even at the very low average price of $2.50 per ton delivered, represents a yearly saving of $52,500,000 to the country at large.

Mr. Zimmerman's calculation is based upon the amount of energy generated by central stations. If account was taken of all steam-power generated the savings would be very much increased. The improvement in the generation of locomotive-power has been as great.

President Harding, in his address to the Agricultural Conference, spoke of the economies that might be accomplished by the electrification of the railroads and the calculation recently made of the gains that may be achieved by the construction of the proposed super-power line between Washington and Boston at an estimated outlay of $1,100,000,000, illustrates what may be expected from such development work. William J Cunningham, professor of Transportation, Harvard University, discussing the report upon the super-power line, has said:

> The typical railroad executive recognizes the advantages of electrical operation. He knows that it will eventually displace steam, at least on lines of heavy traffic and in congested terminals. For his own line under these conditions he would welcome the advent of electricity if a fairy godmother would provide the capital funds and make it possible to earn the additional carrying charges. The problem is not one of engineering. It is essentially one of finance.

Mr. Samuel Gompers has recently given out a plan for restoring prosperity by the expenditure of great sums of capital in construction work of different kinds. Of course it is very desirable that such work shall be carried forward as fast as it can be done and capital is available for it. Here is seen the necessity for the balanced relation to which reference has been made. Somebody must have accumulated the capital with which payment for such work shall be made; evidently such accumulations are in the public interest, and if approximately three-fourths of all the income accruing from capital investment goes directly to labor there does not seem to be any occasion for labor to be alarmed over capital accumulations.

Concrete Housing Projects

A member of the staff of the U. S. Bureau of Standards recently made a trip of inspection covering various concrete housing projects. This is the third trip of the kind that has been carried out and covered the territory in the neighborhood of Pittsburgh, Cleveland, Chicago, and Minneapolis. A Technical News Bulletin of the Bureau summarizes the trip as follows: Three days were spent in the vicinity of Pittsburgh inspecting various types of concrete houses both those built according to monolithic and concrete block construction, including two important projects at Johnstown, Pa., and Donora, Pa. The former includes 89 concrete houses built by the Cambria Steel Co. in 1920 and 1921, while the latter consists of concrete houses of the Lambie type built in 1917 and 1918.

The most notable development in the vicinity of Chicago is the institution at Mooseheart, Ill., built by the members of the Loyal Order of Moose for the education of the fatherless children of the order. The use of concrete has developed to a remarkable degree not only in the construction of the Mooseheart buildings but also in the production of ornamental and architectural concrete.

Inspection of the Morgan Park houses, a development of the Minnesota Steel Co., at Duluth, occupied 2 days. The project includes about 500 houses, most of them being constructed of small concrete units. Other projects included the houses built by the Hydraulic Steel Co. at Cleveland, while at Canton the metal, lumber, and stucco houses developed by the Berger Manufacturing Co. were studied. There is a greater diversity of concrete house types in the vicinity of Youngstown than at any other point, since there may be found the Donaldson and Lambie houses built by the General Fireproofing Co., together with a steel and stucco house of their own design.

Nearby is the well-known project of 281 concrete houses built by the Youngstown Sheet & Tube Co. in 1917. The Carnegie Steel Co. has a housing project located at McDonald in which there are 72 of the Van Guilder type of concrete houses and a very extensive use of concrete in city pavements, sidewalks and sewers. The same company has a project of 50 Van Guilder houses at Steelton.

Prize Awards of Illinois Society of Engineers for Engineering Papers.—Prizes offered by the Illinois Society of Engineers in its annual competition of papers on engineering subjects have been awarded as follows: "Analysis of Errors in Survey Chaining," W. H. Rayner, Urbana, Ill.; "Overflow Chambers in Intercepting Sewers," W. T. McClenahan, Chicago.

Method of Breaking Up Ice Gorges with Explosives

By S. R. RUSSELL,

Technical Representative, E. I. du Pont de Nemours & Co.

Attacking ice gorges and jams by the use of dynamite is a comparatively simple matter. Anyone at all familiar with the use of explosives can, by following instructions, obtain the proper results. Explosives are now so widely used that they can be obtained in practically any locality and a few hundred pounds of dynamite correctly applied at the proper time may result in the saving of many thousand dollars' damage.

Floods due to ice gorges occur usually about the same time each year in various localities. The gorge also is generally formed at the same place in the river or stream. For this reason, therefore, preparations can be made and work started in ample time before the break actually occurs.

Beginning at the downstream end and several hundred feet below the probable location of the gorge, the ice should be practically honeycombed or cracked up below and above the danger point so that when the "rush" comes it will give or move easily without jamming or causing damage. Forty per cent straight nitroglycerin or 40 per cent ammonia dynamite should be used.

Holes from 6 to 12 in. in diameter 10 ft. apart across the stream and 60 to 75 ft. between rows should be dug through the ice. The size of the charge per hole will depend entirely upon the thickness of the ice. It is wise to try a test shot, firing one row of holes at a time to determine the proper charge and spacing. If the ice is 2 or 3 ft. thick, about 1¼ by 8 in. cartridges should be used in each hole. If thicker than this, from eight to ten cartridges or more should be used. The cartridges should be securely tied in a bundle and each charge primed with an electric detonator. The dynamite should be allowed to float just under the ice, and the bundle tied to a stick laid across the hole to prevent the charge being lost. Even better results will be obtained if the dynamite is suspended in the water from 2 to 3 ft. under the ice.

If it is inconvenient to use electric firing, the charges can be exploded by means of fuse and blasting caps, but care should be taken to protect each cap from water by using sealing compound, or smearing heavy grease or soap where the cap is inserted in the dynamite. A good grade of waterproof fuse should be used.

If the gorge or jam has actually formed, it is well to honeycomb the ice below the gorge, as previously described. Then at about midchannel—or what appears to be the weakest point of the gorge—a heavy charge of dynamite should be placed under the ice, if possible. If the gorge is a large one, it may be necessary to fire two or three heavy charges at different points. The size of the heavy charge will depend, of course, on the thickness and extent of the ice mass and may vary from 50 or 100 lb. up to a ton or more. Size of charge must be regulated according to the location and proximity of structure that might possibly be damaged by the explosion. If there are no buildings or other structures nearby, it is well to use large-sized charges in breaking up large gorges. The tendency of most people in using dynamite for blasting ice is not to use enough. The reason is that the work is usually performed by those who have very little knowledge of high explosives and a very exaggerated idea of their force.

Before the ice gave away in breaking the great ice gorge at Niagara Falls several years ago, 2,100 lb. of 60 per cent dynamite were used at one time, distributed in three charges.

A rather amusing case where just the opposite prevailed happened when an ice gorge actually formed in a river near a certain city. The chief of the local fire department decided to try blasting. The chief of police ordered all windows of houses and factories opened within several hundred feet of the river bank, and the factories vacated. No one was permitted to get anywhere near the work. Then, with great fear and trembling, they exploded one cartridge—eight ounces—on masses of ice that would actually require at least 100 lb.

It is well, therefore, in blasting ice to err on the side of overcharging, as this sort of blasting can usually be carried on without fear of injury to adjoining or nearby property.

Provisions of Zoning Ordinance Proposed for Detroit*

The City Plan Commission has drafted the text of the proposed ordinance and has prepared diagrams illustrating its applications and tentative maps of the proposed zones or districts. This ordinance is designed to promote the public safety, health, convenience and general welfare by regulating the height, bulk and use of buildings, whereas the Building Code provides structural and sanitary regulations. It is to protect the property owner from "the folly or greed of his neighbors." It will be administered by the Commissioner of the Department of Buildings and Safety Engineering. Building permits will be conditioned upon conformity with the Building Code and this Zoning Ordinance. For special cases and interpretations there will be a Board of Appeals. Certificates for occupancy will be required for the use of new or altered buildings or for change of use. The Common Council may amend the ordinance after public hearings and report by the City Plan Commission.

Use Regulations.—The city is divided into four classes of districts.

In "Residence Districts," dwellings, clubs, churches, educational and philanthropic institutions, local passenger stations, greenhouses, farming and customary incidental or accessory uses are permitted.

In "Commercial Districts," offices, retail stores, light manufacturing incident to retail sales, and other uses supplying local needs are also permitted.

In "Industrial Districts," all uses except such industries as those emitting odors, fumes, dust, smoke, gas or noise are permitted.

In "Unrestricted Districts" no use hitherto permitted in the city is excluded.

No existing uses are disturbed but all changes must be toward conformity.

Height and Bulk Regulations.—The city is divided into six classes of districts designated according to building height limit, with regulations for each as to height, percentage of lot area that may be occupied, number of families housed per acre and least sizes of yards giving light and air. For dwellings, yards must be uncovered ground, except that low accessory buildings may occupy not more than 40 per cent of rear yard. For other buildings, yards may include open areas above first story. Chimneys, elevators, tanks, ornamental towers, spires, etc., are not limited as to height.

In "35-foot districts," 2½-story dwellings may cover 45 per cent of corner lots, 35 per cent of interior lots and house 20 families per acre. Other buildings may cover 60 per cent of corner lots and 50 per cent of interior lots. Yards are required each side of every lot.

In "50-foot districts" (4 stories) buildings may cover 60 per cent of corner lots or 50 per cent of interior lots. Dwellings may house 100 families per acre.

On large lots in "35-foot districts" single dwellings with extra setback from all lot lines may be 3½ stories or 45 feet in height. In 35 and 50-foot districts, public or semi-public buildings with extra setback from all lot lines may be 70 feet high.

In "70-foot districts" (6 stories) buildings may cover 80 per cent of corner lots or 70 per cent of interior lots. Dwellings may house 150 families per acre.

In "100-foot, 150-foot and 200-foot districts," dwellings may cover 80 per cent of corner lots or 70 per cent of interior lots; other buildings 100 per cent. Dwellings may house 200 families per acre.

Towers not exceeding in area 25 per cent of lot are not limited as to height in "150 and 200-foot districts," but the rest of a building is required to "set back" above the 100 and 150-foot levels respectively.

Prevailing "building lines" in residence districts are to be protected. No present "restrictions" of any kind are annulled.

Exceptions are provided to prevent hardship in special present conditions.

Scale Formation in Steam Boilers.—The U. S. Bureau of Mines has undertaken, at the Pittsburgh Experiment Station, an investigation of the mechanism of scale formation in steam boilers. The object of the investigation is to determine if the character of the precipitates forming in boilers may be made to assume a form in which they do not attach themselves to the walls, and also to ascertain if the material in the boiler wall exercises any influence. The work will be done in cooperation with a company manufacturing combustion appliances, which will bear all expenses. The investigation will probably extend throughout the year.

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*From the Bulletin of The Associated Technical Societies of Detroit, Feb. 15, 1922.

Lighting the Wrigley Building

The impressiveness of the Wrigley building when illuminated at night has been so largely noted and wondered at that we give herewith a brief account of the lighting system as published in "Architecture and Building." For the benefit of those who are unfamiliar with the general facts and circumstances of this building it should be stated that it is Chicago's tallest structure. The ground plan is irregular, and the lines of the building are distinctly those of lightness and grace. It is located at the angle of Michigan avenue, just north of the bridge, thus showing for the entire length of street to the south. Its height and location also make it a most conspicuous object for long distances in other directions. The account of the lighting arrangement follows:

The facing on the building, which rises [illegible] ft. from the bridge plaza, shades from the gray of Bedford stone at the base to a pale cream at the top of the tower. This airy effect is easily distinguished as one of the features of the Wrigley building during the day. At night, this idea is carried out even more forcibly by the lighting on the boulevard side—the lower three stories are very much subdued with the lighting gradually increasing in intensity from the third story until the tower, rising from the parapet of the building proper, is very bright. The tower being visible for a greater distance than any other part of the building, stands out against the night, visible for twenty miles.

To produce this very striking effect, the light is projected by powerful X-ray reflectors using 500-watt lamps mounted on the roof of the Kirk building on Michigan avenue to the boulevard elevation of the Wrigley building. The reflectors are mounted in two large batteries, one of which is shown here. The light is evenly distributed over the front of the building, increasing in intensity with the height until the tower stands out "one blaze of glory." On the roof of the Wrigley building proper batteries of these same reflectors are installed to light three sides of the tower. The turrets and other ornamentations on the top of the tower are brought out in relief by smaller X-ray reflectors which use 250-watt lamps.

The installation of the exterior lighting equipment today consists of 123 reflector units, each using 500-watt lamps and 37 reflector units with 250-watt lamps. Total current consumption is 70,750 watts. This installation is said by lighting men to be one of the finest of its kind ever attempted.

Mr. William Wrigley, Jr., in considering the flood-lighting of this unique building at night, wanted it to surpass anything that he had ever seen and to say the least, that was a problem to solve.

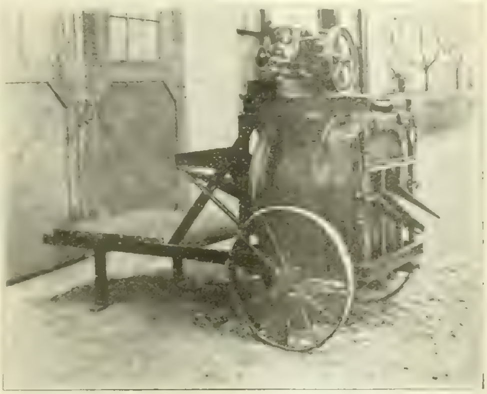
It is planned to light the river elevation of the building by placing the same type of powerful reflectors on buildings on the south bank of the river. When this is completed it will bring the total number of 500-watt units in use to 198. About 80-h.p. is used to generate the current to produce this striking effect at night.

One of the important items in lighting this building was the fact that, being of a light cream terra cotta and being subject to considerable of the smoky atmosphere, it would be necessary to wash the building several times each year. This will be done just as often as is necessary to make the building loom out in all its grandeur at night, like the snow-white sentinel as it appears today. The total cost of installing this flood lighting equipment will approximate $30,000. The cost of operating it each night from dusk until midnight, including the cost of maintenance, lamp renewal and washing the building as often as may be necessary, will be about $80.

Battery of "X-Ray" Projectors for Lighting the Wrigley Building.

New 3-Cubic Foot Concrete Mixer

The accompanying illustration shows the latest addition to the mixer line of the Archer Iron Works, Chicago. This new mixer has a 3 cu. ft. wet concrete capacity per batch. It is built along the same general design of the Archer No. 1 Special and Archer 1-bag mixers. Although conservatively rated at 3 cu. ft. of wet concrete per batch, the drum has sufficient capacity to take care of a half-bag mix on almost any proportion of materials. Like the No. 1 Special and 1-bag mixer the new mixer is equipped with a Fairbanks-Morse engine with Bosch magneto, and is also fitted with clutch and chilled drum rollers. A 1½-HP. engine is used on this machine.



Archer Junior Concrete Mixer.

The San Francisco Bureau of Governmental Research and How It Operates*

Members of the staff of the Bureau often encounter, on the part of persons uninformed as to our work, the opinion that the Bureau is a super-scientific sort of organization, operating along purely theoretical lines—in other words, the attitude that the Bureau's methods are "laboratory" methods, and may not be applied to "practical" affairs.

Such an impression is completely divergent with the actual facts. The Bureau is a staff agency for citizens' inspection, study and analysis of public business. If acts for all citizens, by co-operation with city officials, in the promotion of economy and efficiency in municipal affairs.

The Bureau's methods of operation are along scientific lines, being based upon facts and actual data, rather than unsupported opinion, but instead of being in the realms of pure theory, the methods used are practical to an extreme. The basis for every Bureau recommendation is first-hand knowledge, based on direct investigation and analysis, of the facts in any particular case being considered. The wide field of the Bureau's activities in such practical field studies can probably best be understood by outlining some of the more important of these activities, which, although by no means a complete history of the Bureau's work, are as follows:

Initiating and co-operating in the installation of an accounting system for the city and county, which, although not as yet completed, now ranks very high among municipal accounting systems in the country.

A co-operative study of the fire department organization, equipment and locations, incidental to the adoption of the two-platoon system, resulting in the installation of the two-platoon system at an additional cost of $48,000 instead of $250,000 to $500,000 as originally estimated.

Detailed study of hauling requirements of certain of the Public Works' bureaus with definite proposals as to organization and methods.

Detailed studies of street cleaning organization, equipment and methods (incomplete), from which important results are expected.

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*From "The City," the monthly publication of the Bureau.

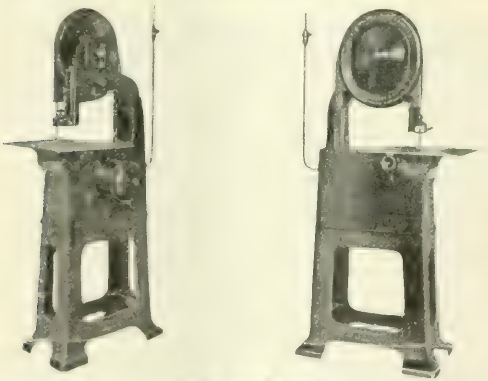
Analysis of the organization, procedure and working methods of every city department and the preparation of organization charts showing field, scope and sub-organization of each such department.

Cooperation with the Civil Service Commission in improving methods of examining applicants for positions as clerks, firemen, policemen and other such large groups.

Study of the revenue situation in San Francisco, resulting in a considerable revision of the license ordinances, which tended to equalize the tax burden, and added considerably to the city's revenue.

New Bench 16-In. Band Saw

A new band saw designed to operate on the electric lighting circuit has been placed on the market by J. D. Wallace & Co., 1401 W. Jackson boulevard, Chicago. This new machine has disc steel wheels, and also is equipped throughout with ball bearings—even the upper and lower guides are of the ball bearing type, the saw bearing on the periphery of the roller. Another feature is the totally enclosed electric motor, which is built into the machine and directly connected to the lower wheel by a fabroil gear and steel pinion. Both gears run in oil to insure perfect lubrication and a quiet running machine. The table is a flattened and ground steel plate 19 by 21 in. It is mounted on a large rocker bearing, which is adjusted to any angle from 45 degrees to minus 5 degrees. An indicator is provided to show the angle at which the table is tilted. The table is mounted in a very simple manner and can be taken off easily and quickly. Safety guards are built into the machine and are a standard part of it. All adjustments are controlled by hand wheels or thumb screws, without the use of special tools or wrenches. The height of this new bench 16-in. band saw is 7 ft. [illegible] in. over all; the table is 42 in. from the floor; floor space required is only 15 by 29 in. The motor, a ½ h.p. General Electric, is ball bearing, and runs at 1,750 revolutions per minute, the saw runs at 3,150 feet per minute. The blades used are especially made for this machine. They are of special steel properly treated and especially cut so as to secure the greatest number of producing hours on this saw wheel. The machine will handle any stock from the smallest piece to the hardest wood 8 in. thick.



16-In. Band Saw

New Combination Portable Electric Drill and Grinder

A new combination portable electric drill and grinder so designed that one motor gives the desirable speed for drilling as well as the proper speed for grinding has been brought out by the Wodack Electric Tool Corporation, 23 South Jefferson street, Chicago. This tool can be used for drilling holes in metal or wood and when used with grinding wheel attachment will cover the average requirements for grinding. It is stated to have a drilling capacity of ¼ in. to ⅜ in. in wood, and when used as a grinder carries a 6 in. by ¾ in. grinding wheel. Two separate speeds are provided, the slow speed for drilling and the high speed for grinding. The complete weight of the tool is but 18 lb., while the motor develops ½ h.p. under load. In addition, this tool is fitted with the switch located in the top handle, of the quick-make-and-break automatic-stop type, which insures the operator of having the tool under control at all times. Aluminum castings and ball bearings are used throughout. The tool is very simple in construction, yet so rugged to withstand the hard service a tool of this kind is frequently subjected to. The motor is of the Universal type, consequently can be operated on both direct and alternating current of the same voltage. The speed change is a very simple operation, as is the operation of changing the grinding wheel attachment in place of drill bit or vice versa.

Combination Portable Electric Drill and Grinder.

Bridge Work in Iowa.—Engineers of the Iowa State Highway Commission completed plans during 1921 for 2,927 bridges and culverts, estimated to cost $4,699,940. The record for other years is as follows: 1919, 536 structures, costing $1,611,300; 1920, 1,074, costing $3,025,606.

Personals

James R. Brumby, Jr., of Marietta, Ga., has been appointed city manager of Ocala, Fla.

H. M. Leighton, president and treasurer of the H. N. Leighton Co., has been elected president of the Northwestern Association of General Contractors.

C. L. Dewey has joined the forces of the Cement-Gun Construction Co. of Chicago, Ill., and will devote his time exclusively to the development of cement-gun contract work.

J. C. Anderson, B. M. Empie and E. E. Empie have organized the Anderson & Empie Construction Co., of Marshalltown, Ia., and will engage in a general contracting business.

Herbert Brooks, Jr., who recently resigned his position as general manager of the Columbus Structural Steel Co., is now identified with the Bellefontaine Bridge & Steel Co. of Bellefontaine, O.

William R. Mead of McKim, Mead & White, architects, New York City, has been given the decoration of Knight Commander of the Crown of Italy by King Victor Emmanuel in recognition of Mr. Mead's pioneer work in introducing Roman and Italian renaissance architectural styles in America.

Obituaries

Guy Leslie Wait, aged [illegible], civil engineer for the Anaconda Copper Mining Co., died Feb. [illegible] at St. Ann's Hospital, Anaconda, Mont.

Harry Abbott Laws, civil engineer in the Survey Department of Philadelphia for 25 years, died Feb. 9 of heart disease. He was 50 years old.

Richard Henry Rice, manager of the Lynn works of the General Electric Co., died suddenly Feb. 10 at Bolton, Lake George, N. Y. Mr. Rice was born in Rockland, Me., on Jan. 9, 1863. He obtained his early education in the schools of that town and was graduated from the Stevens Institute at Hoboken, N. J., as engineer. He first worked with several of the Western railroads and then went to Bath, Me., as a draftsman for the Bath Iron Works. From Bath he went to Providence, working at the Providence Machine Works. He established the firm of Rice & Sargent, engineers, in that city. In 1903 he went to Lynn, being connected with the turbine department of the General Electric Co., and in 1918 was made manager of the Lynn works.

W. G. Bayley, 57 years old, superintendent of the Cincinnati Division of the Big Four Railroad, with headquarters at Springfield, O., died Feb. 15 at his home in [illegible], O. He was born at Hollidaysburg, Penn., Sept. [illegible], 18[illegible]. He was graduated from St. [illegible] Academy as a civil engineer. For five years Mr. Bayley was with the Pennsylvania R. R. He was a civil engineer in Cincinnati from 1886 to 18[illegible], [illegible] at Indianapolis with the Lake Erie & Western R. R. [illegible] he became associated with the Big Four as engineer [illegible] of the Michigan Division July 6, 1891. March 1, 18[illegible], he became superintendent of the Cairo Division, and Sept. 1, 19[illegible], was made superintendent of the St. Louis Division. Aug. 1, 19[illegible], Mr. Bayley was made superintendent of the Cincinnati Division, which position he held up to the time of his death.

Industrial Notes

The Hercules Powder Co. has reduced prices on high explosives, permissibles and blasting powders. The new prices were effective Feb. 1.

W. A. Alexander has been appointed district engineer in charge of the Helena, Mont., office of the Portland Cement Association. The address of the office is [illegible] Bldg., Helena, Mont.

Roads and Streets Monthly Issue

ENGINEERING AND CONTRACTING

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Managament and Office System

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The Campaign Against Road Building

News that serious efforts are being made in various parts of the country to curtail road building programs now under way and projected will come as a surprise to many of our readers. It has been commonly supposed that the farmer's conversion to the good roads cause was complete and permanent, but such is not the case—at least as respects a considerable number of individuals and some powerful organizations.

These circumstances need cause no alarm if they are recognized and acted upon speedily. If complacence with the present pleasing situation in the road field leads to widespread indifference and failure to combat opposition movements, great damage may be done. It is true that, to a large extent, this year's programs are so far advanced that they will go through in spite of opposition; but the same is not true of next year's, and those who have the interests of good roads at heart must exert themselves if the demands for curtailment are not to result in future injury to their cause.

We criticize the judgment, not the motives, of those who would reduce our road activities. The prime motive—the desire of the individual for lower taxes and assessments—is obviously selfish, but is no more immoral than is any other effort at self-betterment. The belief that such reductions will result in real economic savings is a serious error, and this is the fact that must be brought out clearly and in the best of spirit by those seeking the construction of more roads. Data and arguments for this purpose have long been in the hands of most good roads organizations; the present necessity is that they be brought out and used—together, of course, with whatever new material may be available. Here we can only touch on some of them.

An example of the character of opposition to be met is presented in a recent issue of "Michigan Roads and Forests," and is followed by some forceful pleas that the road program in that State be not interfered with. We quote:

"A uniform form of petition was sent to the State Administrative Board, urging that the State definitely limit its road building program and issue no more bonds under the $50,000,000 constitutional amendment during the current year. These petitions have been sent to the various Granges in the State and several of them have been received by the Administrative Board.

"One of the emphatic protests against the move was voiced by Phil T. Colgrove, President of the Michigan State Good Roads Association. Mr. Colgrove had been advised of the concerted action that was being taken, and upon the eve of his departure for California, Jan. 30, he sent the following telegram to Frank F. Rogers, State Highway Commissioner:

" 'Just learned propaganda of Grange to stop building trunk line roads. With Federal Aid appropriated, surveys made and work progressing, this move is fatal to the best interests of Michigan. Farmers who read their tax receipts will discover that the road taxes are the smallest of all taxes. Michigan's splendid work should not be interrupted by proposed method.'

"The State Grange and State Farm Bureau, at their sessions in Lansing last week, favored curtailment of the road building plans of the state, but there was strong sentiment in favor of carrying out the program to complete Federal Aided roads.

"Both the above organizations favored repeal of the Covert Act. The Farm Bureau in its general resolutions in which continuation of road building was opposed, recommended that the Covert Act be so amended that all moneys received for state reward for road building be applied to payment of highway bonds issued by the various counties and that all remaining moneys after payment of such bonds be turned over to the general highway funds of the counties under control of the boards of supervisors.

"Both organizations passed resolutions favoring a tax on gasoline, upon the argument that as motorists are getting value out of the improved roads they should bear a larger share of the expense of road construction and maintenance than they are now bearing."

One of the established principles of the Grangers is that of opposition to the incurring of debt, either private or public. Abhorrence of indebtedness is natural to thoughtful people, but like abhorrence of the surgeon's knife, it is not always a wise guide to action. It should scarcely need to be mentioned that no considerable mileage of roads can be built from funds immediately collectible, and that almost every other important undertaking, either public or private, is similar in this respect.

Construction, a bit at a time, as money can be raised, is in nearly all cases, vastly wasteful—even more through the idleness in which the property must stand for long periods or in its very restricted use, than through the excessive construction cost entailed by piecemeal work. The alternatives, so far as public improvements are concerned, are to collect the money in a fund over a long period and at a low rate of interest, before beginning construction, or to issue bonds. The former alternative defers all use of the improvement for a long time; the latter supplies immediate use and convenience. The former reduces the earning power of each lot of money to a bare interest rate from the time it is collected until the improvement is made; the latter brings the entire investment into full earning power immediately.

Failure to appreciate the principles of earnings and interest and the significance of the differences outlined has been, and still is, an important factor in the opposition to active road construction programs. It must still be explained to many that money paid as interest is not lost, that roads are as much tools for earning money as are barns and plows; and that while the roads add to the comfort and convenience of the farmer and the pleasure and the welfare of the city dweller, they also in most cases (except those of a few distinctly pleasure roads) earn a good return upon their cost through the savings they effect and the increased business they permit the farmer to make. Lack of good roads will limit the farmer's earnings just as certainly as will lack of good soil and lack of tools for cultivating it.

Among other considerations which should be presented with unmistakable clearness to road opponents, and repeated for emphasis, is the thought that roads built from bond sales do not involve a heavy cost to any one during his present hard times; that they are in the main to be paid for in the future as they are used; and that future prosperity will be furthered by them. In this connection the small part of the total tax formed by road taxes is a point to be emphasized. The large contributions of Federal funds which are dependent upon the investment of reasonable amounts of local funds, is another important argument. The roads are needed and the Federal Government is ready to bear a substantial part of the cost, but it will not bear the whole cost.

Another most important task is to overcome the impression prevalent in many minds, that construction costs are now high, and are likely to be greatly reduced. The contrary is the case as respects road construction. A large part of the cost of every road is in common labor, and common labor is now low—in many places too low. This is evidenced by many facts, but what makes the conclusion unescapable is the excess of money over the prewar quantity. Withdrawals of paper currency have reduced the total money in circulation in this country to an excess of about 50 per cent per capita over prewar years but our stocks of gold is 80 per cent per capita above what it was and it is the gold which will ultimately determine the price level. Labor which receives less than 150 per cent of what it got in 1913 is really worse off than it was then and common labor will not remain at such a level. Pertinent data and a clear demonstration of these statements were made by us in an editorial in our issue of Aug. 3, 1921. This editorial entitled "Past and Future Wage Levels" has been reprinted in pamphlet form, and will be furnished gladly to all who may ask for it.

Cement is below the general level of prices and steel shapes, bars and plates are either at or below the 1913 average at the mill. Many kinds of road making machinery are [illegible] too low. We have repeatedly tried in these columns to make it clear that not only is no considerable reduction from the present general price level to be expected but that a steady increase will follow the realization that the depression is over. In this opinion we have ample concurrence of authorities, the latest and most spectacular pronouncement being that from a member of Mr. Babson's staff. The futility of hoping for cheaper road construction is, we think, as clear as any prediction of future economic conditions can be.

Highway Widths

It is but a very few years, indeed, since the recognized standard highway requirement was eight feet of width per stream of traffic. This naturally resulted in the sixteen-foot standard width of roadway, so long and so generally employed throughout the country, except where traffic was of extreme density. The 1922 Good Roads Conference developed a consensus of opinion that 22 ft. should be the minimum width of roads now being built, and that in most instances trunk highways should be thirty feet wide.

This probably represents sound judgment. Highway building programs of the past, like many other great activities, have suffered more from lack of vision and from inadequacy than from too ambitious planning, and it is quite possible that we are even yet failing to appreciate future requirements. True, there are many assertions and certain concrete evidences that this country has about reached the saturation point of motor passenger vehicles, but quite clearly we have not reached the saturation point of industrial vehicles, nor have we probably attained to a maximum use of our highways.

Increased speed alone requires changes in our designs, and we believe that the twenty-foot minimum will not be lowered for ordinary standard usage. We are inclined to think that each case requiring greater width will involve special study and determination. The single thirty-foot or wider pavement will continue to have its uses, but there will probably be many instances of special designs, and of separate pavements carrying segregated traffic.

In common with many others, the editor used to think that sixty-six-foot and one hundred-foot rights of way for public highways involved unreasonable extravagances. In certain instances such probably are extravagant, even now, but for main highways the greater widths are clearly necessary. Not only should there be sufficient width to permit of the widening of pavements and segregation of traffic as may hereafter be necessary by reason of increasing volume, but there should be a space at each side for purposes of control and beautification. The one hundred-foot right of way is today proving a blessing in many instances where it was once derided.

Alive to Present Issues

The necessity of actively combating propaganda such as that mentioned in a preceding editorial against an extensive road improvement program is appreciated by the New Haven Chapter of the American Association of Engineers. In a bulletin announcing a "Prosperity Meeting" of the chapter on Feb. 21, with the mayor of the city as the invited speaker, there is the following piquant analysis:

IMPORTANT TO ALL.

"Stop All Public Improvement, Don't Give Work to Idle Citizens, Let Them Suffer, Taxes Must Be Reduced."

"This in effect seems to be the slogan of certain administrations and associations throughout the State and some of our members are of the opinion that not only is such a policy injurious, but if followed regardless, it is pernicious because it becomes chronic and affects society as a whole.

"The government stops improvement. The cities and towns stop improvements. Private owners stop building. The wage earner and salaried man stop buying. The manufacturer, wholesaler and retailer lay off employees. Business stagnates and there is no chance for it to revive.

"Society is like a human body with government as the heart, and as it beats, so will the rest of the body function. To have a healthy body politic the present false policy should be reversed and instead of administrations being heckled to reduce taxes they should be permitted to look at the matter in a larger light. They should provide work for those that are not interested in a few mills increase in taxation because they are faced with a more important problem of providing bread for their wives and children."

Book Review

Motor Truck Transportation By F. V[illegible] C. E. [illegible] in New York University. Published [illegible] New York, $2.

Reviewed by PROF. C. J. TILDEN

This is a book of 153 pages, covering a dozen or more major topics in the subject of motor truck transportation. The author frankly recognizes the present position of highway transport as a rapidly growing and constantly changing factor in our general industrial scheme. He is a strong advocate of the motor truck as the most satisfactory solution of many of our transport problems, but on the whole he presents his case fairly, with frank acknowledgment of the limitations on this form of transport, and a clear statement of those uncertain factors about which we have a great deal to learn, before the industry can be put on a rational basis. There are 15 chapters which deal with such topics as the future of the motor truck, operating cost factors, transportation laws and cost records, comparison of motor trucks and horse drawn vehicles and their relation to railroads, truck bodies and devices for loading and unloading, trailers, tires, maintenance, etc.

The discussion of operating costs and the economic relation of the motor truck and the railroad is necessarily brief and elementary in a book of such small compass. Although in many cases the author has no solution to offer, he has stated the problem in a way to challenge careful thought and stimulate desire for further information. Chapter VIII on the "Value of Highway Transport Surveys" is a reprint of an address which the author made at a convention in January, 1920. It is a suggestive and interesting document, but one cannot help wishing that it had been amplified somewhat and edited rather more carefully for the permanent status of book form. The summary of topics, however, on page 76, which should be taken into account in making a highway transport survey, is an excellent outline. It supplies a valuable skeleton to anyone who has the task of making a survey for any particular community.

The two chapters on "Bodies" and "Loading and Unloading Devices" are well illustrated with instructive and illuminating photographs. They give an excellent idea of the trend of design and development along these lines. Likewise, the illustrative exhibit in the chapter on "Trailers and Semi-Trailers" is somewhat startling in the extent and size of traction units which it shows. There is a brief chapter devoted to "Pneumatic Tires," and also one entitled "The Motor Truck and the Farmer." In this latter chapter there is a statement which one is inclined to challenge—"If the farmer can distribute direct to the consumer, he can obtain more and the consumer will pay less." This is, or ought to be, a self evident economic principle, but the fact seems to be that the farmer is unwilling to "split" with the consumer. He wants the full market price, keeping the lion's share of profits which would otherwise go to the middle man.

At the bottom of page 128 there is an equation which really sums up the whole transportation problem. This is: "economical distribution = economical collection + economical transportation + economical marketing," and the author points out that economical transportation is the connecting link. There is a discussion of the ways in which the farmer may be connected with the market and of the value of motorizing farm industry. The efforts of the rural post routes of the Postoffice Department are especially noted and commended. The author does not contend that in every instance the motor truck should supplant the horse and the railway, but that farmers generally should make a careful canvass of the local situation to be sure that the collection and distribution methods in use are the best.

The final chapter in the book is entitled "Good Roads." As might be expected, this is a strong plea for a greater mileage and a heavier type of construction for highways throughout the country. The author points out the striking way in which the manufacture and use of heavy trucks has gone beyond the capacity of the roads which they use. The well known fact in railway development is mentioned—that whereas the early T-rails weighed but 36 lb. to the yard, there are now in use rails which weigh as high as 125 lb. to the yard. It is rightly pointed out that the great increases in weights of railway rolling stock could not have been made without corresponding increases in track strength. The analogy with highways is evident and a strong plea is made for building stronger and more expensive highways and providing for proper maintenance. The author points out the economic advantage of such highways in permitting the use of greater capacity trucks at greater mileage with less wear and tear and less fuel consumption. All these arguments are sound.

But one wishes that the author had taken a fuller cognizance of some of the more fundamental economic considerations. To go back to the railway analogy, only a relatively small mileage of track is built with 125 lb. rails. There are still many miles of railway track using the lightest weight rails and these tracks are doing their duty in the great scheme of transportation. We need many miles of highways of the best and strongest sort, but we need far more miles of lighter and less expensive construction. The type of road which should be built for a given community depends on the needs of that community or of the various communities which the road connects. If a road costing $5,000 a mile can serve the needs of a locality, it would be criminal waste to build a road costing $50,000 a mile. There is the other side, of course. If a community needs a highway system costing $50,000 per mile, it is economically unsound for it to spend but $5,000 per mile on its roads. The author refers to the proposed "Ideal Section" of the Lincoln Highway Association. This is an interesting experiment, but it should be kept in mind that a highway section which is ideal for one part of the country may be absolutely wrong from every point of view in another community.

In general, the book under review may be commended as highly suggestive and interesting to anyone concerned with the vital problems of Highway Transport. With the experience which the author has had in dealing with these problems, probably no one knows better than he its limitations and short comings. A future edition might well list a bibliography, and a well-made index would add greatly to the value of the book. For classroom work, it must, of course, be supplemented by outside material and written exercises. For both undergraduate and graduate courses, however, it may be used to advantage as a basis. The author has ventured on a field in which there is very little in the way of settled and permanent literature, and is to be congratulated on having made a distinct contribution to this field.

Highway Investigations Now Under Way Or Pending

In connection with its progress report presented Jan. 16 at a meeting of the Advisory Board on Highway Research, the Committee on Highway Research Program, of which Prof. T. R. Agg is chairman, gave the following list of highway investigations of note which are now under way in the United States:

1. Economical highway grades at the Iowa Engineering Experiment Station; 90 per cent completed.

2. Tractive resistance of certain types of vehicles and certain types of surfaces, at Iowa Engineering Experiment Station; under way.

3. Tractive resistance of certain types of vehicles on concrete road surfaces, including a study of methods of observation and of internal power losses in vehicles and tires, at Massachusetts Institute of Technology in co-operation with the Bureau of Public Roads, and at Yale University.

4. Tractive resistance and economical grades at University of Michigan.

5. Effect of relative air speed, at Kansas Agricultural College.

6. Establishing of the relation between traffic and maintenance costs; recently inaugurated by the Bureau of Public Roads.

New researches for which arrangements are complete or are pending include the following:

1. Relation between the roughness and the rigidity of a road surface and rolling resistance, at Iowa Engineering Experiment Station in co-operation with Bureau of Public Roads.

2. Elements of cost of highway transport, by Society of Automotive Engineers (pending).

3. Operating costs of motor transport. Project pending for studies in connection with motor transport activities in and near Los Angeles.

New Methods of Gravel Road Construction in Iowa

To the Editor: The article entitled "New Methods of Gravel Road Construction in Iowa," consisting of quotations from a paper by Mr. J. F. Reynolds of Storm Lake, Ia., published on page [illegible] of your issue of Feb. 1, 1922, is interesting to many of us here in the middle southern States because of the very radical departures from the methods now used in constructing gravel roads in this section. It would be interesting to have further detailed information concerning the principles as to crowning practice, etc., of gravel roads constructed or contemplated in Iowa. It is assumed that the conditions regarding subsoils must be different from those here in the south. Because under our conditions it is safe to predict that such a method of construction would not prove satisfactory unless it were possible to keep traffic off the road until the gravel surfacing became heavy enough to protect the grade. This would be necessary because the method described by Mr. Reynolds assumes that the traffic is a factor in compacting the gravel during the construction period.

Our experience has led to the conclusion that a certain percentage of clay is necessary in order to secure a tight, compact surface. All sand, however small, carries a certain proportion of voids and some very fine binding material, clay for instance, is necessary to fill these voids and get a surface that will be compacted, therefore more free from the tendency to internal movement, with consequent destruction.

Another very great source of trouble in this section is the moisture or rain water that passes down through the sand-filled gravel surface and into the road bed, softening it up and bringing about a breaking up of this surface on account of heavy traffic. The clay binder in a gravel road, if of the proper kind, will largely prevent this moisture from going through.

The author of the paper under discussion advises that the necessary clay for binding the gravel is worked up from the subgrade. It would appear as though the method pursued is upon the basis that this binding material works up gradually as the building up process proceeds, and that it is not thrown in from the sides of the road way. The writer is of the opinion that this plan could not be followed after the first coating of gravel was placed and became packed, because in line with other portions of the paper where it is explained that the surfacing gravel is moved in from the sides of the road from time to time as certain portions become packed, there would be no chance for more clay to work up through the bottom layer, unless the whole of the gravel remained more or less loose, and in an unpacked condition until the whole road was constructed. This the writer takes it, is not the process under the method suggested by the author.

Another startling suggestion is that insistence is had upon placing this gravel surface upon a level subgrade. Our experience here has proven that if this subgrade is crowned, the water getting down to the top will be shed to the sides of the roadway more readily. This same point applies with reference to the top surface of the gravel. Because if it is properly crowned, the slight depressions that occur sooner or later on account of wear do not hold the water as they do when the top surface is flat.

With reference to the method of placing the gravel loose on both sides of the road or embankment and then depositing enough in the center so that there remains only about an inch of material for the first coat seems to require that traffic would have to be kept off of this road immediately after a rain and for such length of time as would be required for the embankment and this layer of gravel to dry out enough to sustain the traffic. Here in this country the subgrade when wet becomes soft, so that for periods of several months at a time it would be utterly out of the question to have a road open to traffic if it were being constructed as suggested by the author of the paper under discussion.

We have few actual facts regarding the wearing qualities of different classes of gravel roads and while it is admitted that a sand-filled gravel often results in a smoother road than does a clay-filled gravel, we are gradually reaching the conclusion that the clay-filled gravel withstands wear a much greater length of time than does the sand-filled gravel, although the clay-filled gravel will eventually present a rougher surface to the traffic. In this country we have not yet passed the development stage, or reached the point where we are concerned so much about a smooth boulevard as we are about a hard-surfaced road that will permit the safe passage of farm products from the farm to the markets. Expressed in different terms, we are constructing roadways, not speedways.

One familiar situation in this section of the country is that the subgrade consists of a material that becomes very soft after a rain, so soft, in fact, that several inches of gravel will not sustain ordinary traffic. If traffic is permitted on such a road, it results in a mixture of mud and gravel, then a great deal more gravel is required to obtain a surface that will not break through because of this excess percentage of clay.

The writer has made a study of the gravel road problems here in this section, and as the plan suggested by Mr. Reynolds is so radically different he would be very much pleased, indeed, to secure information as to the results obtained by Mr. Reynolds and also a more detailed description of the physical conditions under which the Iowa road is constructed.

Memphis, Tenn. CHAS. H. MILLER.

National Forests Roads

To the Editor: You will be interested to know that the secretary has just approved the definite apportionment of the $15,000,000 for forest roads under the Federal Highway Act of Nov. 9, 1921. The national forests contain a total of more than 156,000,000 acres of land in the ownership of the United States and embrace much of the most rugged, densely timbered and least developed regions of the country. The need of a complete system of roads and trails for the protection, management and development of these vast regions is obvious.

The work of providing an adequate system of roads and trails in the national forests has been progressing steadily since 1905, when the Forest Service became charged with the administration of these regions. Early appropriations were small, however, and it was not until recent years that impressive progress has been made upon the work. Appropriations previous to that in the Federal Highway Act of Nov. 9, 1921, consisted of $19,000,000 under the acts of 1916 and 1919, and also a provision in an act of 1913 which permitted the Forest Service to use for improvements 10 per cent of the receipts each year from the sale of timber and other forest products. This latter fund has amounted so far to slightly more than $3,000,000. Under the past appropriations there has been expended about $20,000,000, but a great deal of work still remains to be done.

According to the best estimates prepared by the Forest Service there are about 5,400 miles of road still required to complete the state highway systems traversing the national forests or contiguous to them. About 8,500 miles of roads are needed to complete the county highway system within the forests. Additional roads required, principally for the protection and utilization of the resources of the national forests aggregate more than 13,000 miles. Aside from the roads, the pack trails needed in the national forests, principally in connection with fire protection work, will entail about 40,000 miles of further construction. The total cost of providing all these transportation facilities will involve an outlay of approximately $140,000,000. F. E. CONNOR,

Acting Chief Engineer, U. S. Forest Service.

Washington, D. C.

Cost of Horse Maintenance in Manila

To the Editor: Having noticed the item of "Cost of Horse Maintenance by City Departments," in your Nov. 16, 1921, issue the undersigned believes the following information regarding the average cost of maintenance of City Departments in Manila for the year 1921 may be of interest:

One American draft horse:	
Hay	$227.18
Oats	[illegible]
Straw	[illegible]
Total	[illegible]
One American mule:	
Hay	$147.87
Oats	115.24
Straw	9.13
Total	$272.34

SANTIAGO ARTIAGA,

Manila, P. I. City Engineer.

Construction Features of I. W. Carr Concrete Road

By JOHN C. SERIGHT,
City Engineer, Elwood, Ind.

The construction of this road, as it came under the observation of the writer, presents some interesting features that are well worth noting.

The I. W. Carr road was the first to be petitioned and allowed under the county unit road law of Indiana. It is 33,133 ft. in length, running from the city limits of Elwood, north to the south line of Grant county, and constitutes an important link in the Hills and Lake highway from Indianapolis, to the lake resorts in northern Indiana. In order to take care of the extremely heavy traffic following the highway, M. A. Steele, county engineer, incorporated two unusual features in the specifications.

Trouble having been encountered in the past in the use of 1-course pavement, owing to the presence of soft rock in the aggregate, Engineer Steele specified a 2-course pavement, the base consisting of a 1:2½:4 mix, with a top course of a uniform thickness of 2 in., proportioned 1 part cement to 2 parts sand. Another variation from the usual specifications is in thickness, the pavement being 18 ft. wide, 7 in. at the sides, and 9 in. in the center. Laid on a flat grade. ⅜-in. expansion joints were specified every 50 ft. No reinforcement was used.

The contract for this road was let Jan. 15, 1921, but owing to the failure to sell the bonds, work was not started until July 5, 1921, when ground was broken. Paving operations began July 30, and ceased Oct. 21st, with 36,000 sq. yd. completed. August 3rd ushered in a series of rain storms that continued during the balance of the working season. At no time was the paving crew able to work continuously for a week, and the constant rain kept the subgrade soft most of the time. This was a big factor in slowing up operations, but the final analysis showed that the hourly average was 80 sq. yd. per hour, or 200 cu. yd. of concrete placed per 10 hour day—nothing spectacular, but, considering all phases of the operations, an excellent record. Table I shows the daily progress of the work.

Several methods of handling the material were considered but the final decision was to place the aggregate in stock piles—500 ft. apart, on the subgrade, handling from them to the mixer skip by the use of six horse-drawn brickyard carts. The cement was hauled by trucks direct from cars and piled on racks outside the forms, being dumped into the skip by hand.

It might be well to say in passing that the contractors estimate the use of the racks saved enough cement to pay for themselves during the first shower. No cement was lost from water reaching it from below. These racks were made 14 ft. long by 18 in. wide and consisted of 2 by 4 pieces set on edge and spaced 2 in. by use of 2 in. by 4 in. by 6 in. blocks. Hand holds were placed at each end to facilitate carrying and as fast as racks were emptied they were carried forward by the cement dumpers and placed in position for the next truck load. The racks were made 14 ft. long as this length—when the racks were placed 10 ft. apart—held just 75 sacks—piled 5 high, the amount needed for 25 ft. of roadway. The trucks used for hauling cement were 3½-ton capacity and carried 75 sacks to the load which was an added advantage in placing sacks accurately. Little trouble was experienced in getting the sacks placed so as to reduce the carrying to a minimum.

General View of Operations on Carr Road.

The carts used for carrying the aggregate to the skip represented an investment of about $800, this figure including the cost of side boards and harness complete. The operating cost where the horses and drivers were both hired amounted to $3.75 per day per cart; the cost on the carts drawn by horses, owned by the contractor, being $2.75 per day per cart. Eight shovelers were used in charging the carts, four on gravel and four on sand, in addition to the drivers who helped shovel their own loads.

The contractors used a 21-E Multifoote paver of the boom and bucket type. In laying base a 4-sack batch or 26 cu. ft. of sand and gravel was hauled, which proved to be a maximum load for one horse under favorable condition of the subgrade. In order to haul this amount it was necessary to increase the 20 cu. ft. capacity of the carts by adding 3½-in. side boards. These boards were bolted on so as to be easily removed. A center board was placed to divide the box into 16 cu. ft. and 10 cu. ft. compartments. For the top course the 16 cu. ft. side was used, making an 8-bag batch.

As the work progressed it was found that the increasing softness of the subgrade was holding back the batches, the horses becoming fagged and slowing up the work in the afternoon. It was accordingly decided to remove the side boards and run a 3-bag batch of base and a 6-bag batch of top. It was found that nearly as much concrete could be [illegible] under bad conditions [illegible] batch [illegible] the 3-bag batch under favorable conditions.

All the grading was done between the stock piles and mixer [illegible] carried out between the forms. This permitted the making of a practically perfect grade at little expense. It was found that two men with picks and shovels and [illegible] Austin drag and Fresno scraper, [illegible] in keeping the subgrade in excellent condition for several hundred feet ahead of the paver. This method of the grading proved most economical.

It was decided that a finishing machine could not be used to advantage on this particular job owing to the two course specifications, so a hand templet was made [illegible] by 20 ft. The lower surface was covered with steel to protect the bottoms and edges against excessive wear. In order to bring the templet down to the base a section 2 in. deep by 16 in. long was removed from the bottom at each end. The length of 16 in. permitted the required sawing motion in striking off the base course. In striking off the top an oak block with tenon attached was inserted at each end and the tenon fastened in a mortise by an iron pin. Finishing was accomplished by the use of two belts, one of 4-ply rubber belting 10 in. wide, the final finish being given by the use of a 3-ply canvas belt 10 in. wide. All work was gone over twice with each belt.

[illegible]

Date	Feet	Sq. Yd.	Time Lost	Remarks
Oct. [illegible]	[illegible]	[illegible]	[illegible]	Starting [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]				Rain
[illegible]	[illegible]	[illegible]	[illegible]	Wet grade [illegible]
[illegible]				Sunday
Nov. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]				Rain
[illegible]				Rain
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]				Sunday.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] water lines
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	Rain
[illegible]				Rain
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]				Sunday
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]				Rain
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]				Rain
[illegible]				Rain
21				Sunday
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] discharge
23	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] culvert [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]				Rain
[illegible]				Sunday
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	Rain
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]				Rain
[illegible]				Sunday
[illegible]				Rain
[illegible]				Rain
[illegible]	[illegible]	[illegible]	[illegible]	Wet grade [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	Water lines [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]				Sunday
[illegible]	[illegible]	[illegible]	[illegible]	Wet grade [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	Rain
[illegible]				Rain
[illegible]				Sunday
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]				Rain
[illegible]				Rain
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	Wet grade
[illegible]	[illegible]	[illegible]	[illegible]	Wet grade
[illegible]				Sunday
[illegible]				Rain.
[illegible]				Rain
[illegible]	[illegible]	[illegible]	[illegible]	Wet grade [illegible] bag batch.
[illegible]	[illegible]	[illegible]	[illegible]	Wet grade
[illegible]				Rain
[illegible]				Rain
[illegible]				Sunday
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]				Rain
[illegible]				Rain
[illegible]				Sunday
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]				Sunday
[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

In placing expansion joints the engineer required that the joint be cut to crown and set ½ in. below the surface after finishing the joints the filler was pulled up to ¼ in. above the pavement with tongs and left in this position. To prevent rough joints a thin bulkhead was necessary, so one was constructed to the crown of the road of 10 gauge steel with a ¾ in. by ¾ in. angle iron riveted along the top. In placing the joint the filler strip was placed under the projecting edge, thus preventing any possibility of its being disturbed by the templet, and insuring a perfect joint.

Brick Cart, Cement Rack and Paver.

The batches were so proportioned that three batches of top were used to cover six batches of base. Each driver knew that he was expected to bring up two batches of base and follow it by one batch of top, which left little supervision to be exercised. What little was required was done by one of the cart drivers. When this driver was at the stock pile, calls for extra batches were signalled by the mixer operator by the use of the whistle on the paver.

Hand Templet

Curing was accomplished by use of canvas shades which were placed over the finished concrete until it had hardened sufficiently to bear a man's weight. When these were moved up, straw was spread to a depth of 3 in. and kept wet for 10 days. After the curing was completed the straw was raked to the side of the road and burned.

More than sufficient water for all operations, including curing, was furnished by a 2 in. C. H. & E. triplex pump, driven by a 6 h.p. Fairbanks-Morse engine, two of which were mounted one on each side of the pump, thus preventing any failure in the water supply. The maximum distance pumped was 2¼ miles.

The aggregate was unloaded from cars by a Little Giant crane with ¾ yd clam shell bucket, about five minutes being required to handle a 5-yd truck load. Lack of space prohibited the use of bins, but no trouble was encountered in getting material on the grade in quantity sufficient to meet the paving requirements. Eight trucks were employed. The trucks were of 5 and 7½-ton capacity and hauled from 4 to 5½ yd per load. The hauling contract was handled on a yard mile basis using ½ mile hauls as a unit.

The contractors are expecting to make a few minor changes in their methods on resumption of work, which is believed will increase the efficiency of the present force and cut down the handling cost. Among these is the installation of a Barber-Greene loader for placing the gravel in the carts, the use of a turntable or platform in front of the skip to facilitate turning and backing, and wider tires on the cart wheels. The use of a chute instead of a boom and bucket delivery on this type of pavement would also speed up the work and permit a reduction in the spreading crew if the specifications permitted its use.

Canvas Shades for Curing the Concrete

The following crew handled the paving operations:

1—Mixer operator.
1—Foreman
[illegible]—Spreaders.
2—Finishers.
2—Form setters.
2—Form handlers
[illegible]—Cement men
[illegible]—Dump man
[illegible]—Cart drivers
[illegible]—Sand shovelers
[illegible]—Gravel shovelers
[illegible]—Curing man
1—Water boy.
1—Sack boy (also [illegible] truck)
1—Sack cleaner
1—Pump man
1—Fireman
2—Cement truck drivers
2—Helpers
1—Gravel checker at cars
1—Gravel checker on grade
1—Cement checker at cars
1—Mechanic

The work was performed under the direction of M. A. Steele, county engineer, and Paul Phipps, assistant engineer. The County Commissioners are A. L. Hiatt, Charles Poindexter and Wm. L. Pierce, all of Anderson, Indiana. Harmon & Harmon of Elwood, Ind., are the contractors.

South Carolina Proposes Big Road Improvement.—A proposal to spend $34,000,000 within six years and to complete within that time 4,000 miles of the State system, more than 600 miles of which would be hard surfaced and the remainder surfaced with sand-clay, top soil, or gravel, is to be urged before the present session of the Legislature of South Carolina. If this greatly expanded program is carried out, the State will match all of the Federal-aid money now available and any future appropriation that may become available. Funds will be raised by automobile licenses, by continuing the State-wide 2-mill property tax, a 1-cent-per-gallon motor fuel tax, and a bond issue of $10,000,000.

Road Building Grown to Big National Industry.—Road building is one of the Nation's largest industries, according to statistics compiled by the Bureau of Public Roads, United States Department of Agriculture. In December, 1920, less than 600,000 men were employed in the steel and iron industry. It is estimated that last year something like 750,000 men were engaged in making, selling and repairing automobiles. As compared with this approximately 1,000,000 men labored last year throughout the road-construction season in building and repairing the country's highways.

Comparative Cost of Road Grading with Tractor and Mule Outfits

Travis County, Tex., is divided into four commissioners' precincts, each having a commissioner elected by the people of that precinct. Each commissioner is an ex-officio road superintendent of his precinct, and has direct charge of all roads and all road equipment for the precinct, and is in direct and actual supervision of such equipment in building, repairing or maintaining all of the roads.

The records show that on the 1st of September, 1920, the county had road equipment for the four commissioners' precincts aggregating in value approximately $28,000. This equipment was represented by mule teams, graders and scrapers, there being approximately eight or ten teams to each commissioner's precinct. On the first of September, 1921, the inventory for the county showed that the road equipment totaled $45,000. This increase in the value of the road equipment within the year was caused by the purchase early in the year of about $17,000 worth of tractors and graders, each of the three commissioners having purchased a 5-ton "Caterpillar" tractor for use on the roads, together with the necessary grading machinery. After having used the three 5-ton "Caterpillar" tractors for about eight months, the Commissioners' Court purchased additional equipment to the extent of three 10-ton tractors and one 5-ton tractor, together with the necessary grading machinery, making the total value of the road equipment on Oct. 1, 1921, $75,000.

For the purpose of showing the savings gained over team drawn outfits in Travis County, the operation of the 10-ton "Caterpillar" tractor in Mr. Brodie's precinct affords a fair example. The records show that Mr. Brodie had operated his mule team outfit, consisting of five teams, grading equipment and eight men, for the first nine months in the year at a cost of $5,956.81, and during those nine months had constructed 31 miles of road, at a cost of approximately $200 a mile.

The records show that for the two months that the 10-ton "Caterpillar" tractor has been at work on the roads in his precinct he has constructed 25 miles at a cost of $1,170, or $46.80 per mile, this $1,170 taking into consideration the wages of two men, one operating the tractor and one operating the grader, all expenses for ordinary wear and tear on the grader (there being no repairs whatever on the tractor), and all interest and depreciation charges on both machines.

Tractor Grader Outfit on Travis County Work.

Roads built by the mule teams and by the tractor were in all respects alike as far as condition of soil and hills were concerned, the roads upon which each of them worked running west from Austin to the county line and being of adobe and limestone formation, with many boulders both in the ditches and in the surface of the road. The mule team outfit built only a 20-ft. road from ditch to ditch, while the tractor in its work built a roadway that would approximate 35 ft. from ditch to ditch.

The Highway Maintenance System of Pennsylvania

Its Organization and Operation Described in a Paper Presented at Omaha Meeting of the Association of State Highway Officials

By W. A. VAN DUZER
[illegible] Maintenance Engineer, State Highway Department of Pennsylvania

The most important preliminary step in any private or public undertaking is its proper and logical financing. Funds should be made available each calendar year so as to permit the department to proceed with its studies and authorizations during the winter months.

I believe a highway engineer, knowing his traffic and having a history of the road's behavior in the past and the type of maintenance it received, can prescribe very intelligently at least five months in advance what the road will need the next season. This gives him and his organization plenty of time to perfect their plans, study the proper equipment and, if necessary, receive bids on the requisite materials, thus assuring, to a great extent, the completion of work before the advent of the season of heaviest travel.

Fixed Revenue for Financing Maintenance.—The uncertainty as to the time that an appropriation will become available as well as the amount that will be appropriated are the principal reasons that have made it absolutely necessary to provide a fixed revenue to finance our ever-increasing maintenance. It is but natural that a legislator, desirous of securing a large proportion of the maintenance funds for his county, should consider it his duty to his constituents to insist that these funds should be appropriated in county units, and a small fund provided which could be used at the discretion of the department in taking care of unforeseen contingencies.

But traffic conditions, which are ever changing, have in the past few years become the real problem in proper maintenance, and are the disturbing element in specific county appropriations. The construction of a certain unimproved link, or the erection of mills, shops and other property along a highway can increase traffic to such an extent that appropriations made for a road a year or two in advance cannot meet its requirements, and therefore cause consequent deterioration and eventually make reconstruction necessary.

To obtain the best results in any business, whether it be state or private, there must be a fairly definite time within which funds become available, in order that the work may be properly planned. Legislators, realizing this fact and being imbued with keen business sense, in many states have written into the statutes a provision that the fees derived from motor vehicle registrations may be applied towards the maintenance of highways on their state system.

In this manner the control and distribution of these funds are left to a great extent in the hands of the department and place it in a position to meet contingencies as they arise, thus assuring proper attention to the heavy traveled through roads. Experience has shown that this is the logical manner of handling this very important part of the problem.

Owing to the small mileage involved, the maintenance of roads not on the state highway system, but constructed with the assistance of the state, or special maintenance on main trunk lines in boroughs or towns, can be taken care of by direct appropriation. These appropriations, however, should be made in a lump sum for the whole state.

Preparation of the Maintenance Budget.—The intelligent distribution of these funds must of necessity result in a budget, this budget being prepared from annual estimates furnished the main office by the representatives in the field. For convenience, we have divided these estimates into six general classes. Indirect expense is a charge covering salaries and expenses of the field offices and forces. General repairs, as the term implies, takes into account the different classifications for the proper maintenance of the total mileage of highways, the crowning and dragging of earth roads; placing of drainage other than bridges, and the necessary repairs to improved roads. Resurfacing, which includes the reconstruction of the different types of pavements already laid, either with the same material or with a higher type of construction. Surface treatment, which includes the purchase and application of the bituminous material and the chips or other covering material. Bridge construction, and repairs to tools and equipment, the last of which covers all necessary repairs to the tools and equipment of the maintenance division.

The preliminary estimates are prepared by the field representatives after a careful and thorough study of each route. The roads are gone over foot by foot, distributing each estimate among the several units of work coming under the various classifications. We will not allow any guess or approximation and hold the engineers strictly to actual figures, so that each engineer has a personal pride in seeing that the work is done within his estimate.

These estimates are totaled in the maintenance division under the different classifications and are gone over very carefully. In the event that the estimated amount required for these roads is in excess of the estimated revenues, it is necessary to make reductions. In the estimate for general repairs, the reduction is accomplished by comparing such estimate with the amount of money expended during the preceding three years upon the different roads, always endeavoring to develop work of a permanent character, such as widening, construction of guard rail, and the placing of surface and subsurface drainage at particular locations. The reduction in estimates for resurfacing is made after a personal inspection of each project by a maintenance inspector from the Maintenance Division, who takes into account the importance of the road, the traffic, and the possibility of substituting cheaper repairs. Reduction in surface treatment estimates is made by a personal inspection of the roads and a reference to the chart showing the character of the treatment they received in past years, together with an appraisement of the probable traffic that the road will carry during the coming season. Reduction in the bridge construction estimates is taken from the bridge records kept in the main office. These records are compiled from an actual inspection of each bridge, made by an engineer of the Bridge Division, which gives in detail the physical condition of each structure.

These estmates are then returned to the engineers with notations as to the advisability of the reduction or elimination of certain work and after the corrections have been made are again forwarded to the main office for approval and the issuance of the necessary authorizations.

Co-operation With Construction Division Necessary.—In the preparation of the next season's work the closest co-operation exists between the Maintenance and Construction Divisions and whenever traffic requirements become such that our maintenance costs show the present type of construction cannot be held with economy, that particular section is recommended for a higher type of pavement.

When our present system of highways was taken over by the state it included 396 miles of toll roads. The majority of these roads had been built of limestone macadam, and, due to a lack of revenue and increased traffic, had deteriorated to such an extent that when we assumed their maintenance it was a real problem to make such temporary repairs as were necessary to carry them over until such time as funds became available for more permanent work.

In order to get the full benefit of each year's work, we early determined upon a regular maintenance program; that is, a definite program of resurfacing certain roads was planned for several years ahead with the thought of ultimately giving us improved through highways.

Authorization of Work.—Upon receipt of the final estimates, authorizations for the different classes of work are issued from the Maintenance Division. A code number system is used to readily designate the type of work and approximate location. These authorizations are issued in quintuple, one copy going to the several interested divisions or bureaus. This includes a copy to the Auditing Division, from which an account is opened up chargeable to this authorization; one to the Management Division as the co-ordinating division of the department; one to the Purchasing Bureau, in order that purchases can be checked against the authorizations; one to the Maintenance Division, for the purpose of record and control, and one to the district engineer, which is his notification of the specific amount he has been allotted for a particular project.

This authorization is the instrument used to control the funds and in no case can it be exceeded. It denotes the funds which are to be distributed over the entire season and, in the case of general repairs, the entire length of the route in the specified county.

Field Control of Funds. Our field control of funds is vested in an engineer's authorization, by which it apportions to the superintendent the funds for a certain definite amount of work which is listed on the face of the authorization, excepting in the cases of surface treatment and resurfacing, when the entire amount of the department authorization is issued. The engineer's authorization is issued in triplicate and forwarded to the Maintenance Division for approval. One copy is kept in that division for record and the other two returned to the district engineer, who retains one for his file and forwards the remaining copy to the superintendent as his notification that the work is authorized.

A special single entry ledger is used both in the field and main office to keep a record of expenditures. The purchase order, which is the authority for a vendor to furnish certain material to the department, is considered as a liability. The main office receives a report each month upon each authorization issued, according to classifications. This, being summarized, gives us the total amount expended each month under each classification on every route in the entire state.

In order that there may be uniformity in all office procedure, a regular system of field office inspection and audit is employed. We can transfer any field representative from one office to another and the same system of bookkeeping and filing will be in effect.

Occasionally, the funds authorized for a certain project will be in excess of those actually required and by means of a cancellation and transfer report the engineer, with the approval of the maintenance engineer, may transfer funds from one project to any other authorization in his district coming under the same fund. Upon the completion of an authorization and at the end of the year a report is compiled by the superintendent, which itemizes all payrolls and purchases. This is in turn checked by the district engineer's office and is forwarded to the auditing division in the main office for check and record. Any unused amount, not specifically transferred to other work, automatically reverts to the general fund.

Cost Accounting System.—In the cost accounting the Hollerith tabulating system is used. Cost records are prepared from progress reports submitted by the field. These reports show the cost of each of the different items coming under the particular classification, and are filed under route number and by different years. By referring to them we have a record under the jurisdiction of the Highway Department.

This gives you a brief outline of the functions necessary to the proper financing of maintenance work. The financing and organization are really so closely related that, in order to make certain details of the financing as clear as possible, it has been necessary to borrow some of the functions which would ordinarily come under organization, such as the checking and revision of estimates, issuing of authorizations and cancellation and transfer of funds.

Organization for Maintenance Work.—An organization, to operate with as little friction as possible, must be so planned that divisions of authority do not overlap. Its principal success depends upon proper planning. This particularly applies to resurfacing and surface treatment work. The three outstanding features in planning a job are labor, equipment and material. Labor is taken care of by the local representative in the field. The equipment requirements of each engineer are submitted to the central office at the beginning of each season, showing the estimated time that the equipment will be in use upon each project in his district. This includes rollers, trucks, sprinklers, concrete mixers, asphalt plants and dump wagons, together with the available supply of equipment in his district. From this, a working chart is compiled showing the total amount of equipment in use in each district and the surplus which can be transferred to other districts in the state.

The purchase of materials is made by requisition drawn by the superintendent and approved by the district engineer and the central office. If competitive bids have not been previously received the superintendent asks for quotations from at least three producers and, providing the material meets the department's specifications, a purchase order is drawn upon the vendor submitting the lowest quotation by the Purchasing Bureau.

The regular payment of approximately 8,000 men twice a month for seven or eight months in the year is a problem of some magnitude, for it means that if we are to keep efficient labor we must pay them promptly and correctly. We use a time card with the workman's name and number on it, the workman retaining the card. The number of hours worked is punched by the timekeeper or foreman each day. Our caretakers send a daily report card to the superintendent, showing the number of hours worked and the kind of work performed, these men working alone under the direct supervision of the superintendent. We believe the post card system is an incentive for the caretaker to produce good results.

Time Sheet.—The foreman keeps a time sheet and at the end of the pay period prepares a progress report showing the time worked by each workman upon the different units of work which is mailed to the superintendent with the time sheets. He checks the progress report and forwards it to the Auditing Division, the time sheets being retained in his office until the receipt of the checks. The checks are delivered personally to each workman by the superintendent, who receives the time card as a receipt for the delivered check. These time cards are then sorted according to route and pay period, and periodically forwarded to the Auditing Division where they are filed as a record of payment made. We think the most important feature of this method of payment is the personal contact with the superintendent. In this manner he becomes better acquainted with his employees and by checking up frequently in going over the road he can readily pick up any attempt to defraud the state.

From time to time pamphlets of instructions are issued to the maintenance employes, but we believe that the best results are obtained by frequent circular orders and the careful preparation of standards for carrying out the different methods of maintenance work.

As is noted above, considerable time is taken in the planning and scheduling of work previous to the actual operation. A schedule of the various types of maintenance showing the tentative dates of beginning and completing work is submitted by the district engineer to the main office, and a careful followup is employed to assure the completion of all work authorized.

How Complaints Are Handled.—One of the most important functions of the Maintenance Division is the handling of complaints. These receive careful personal attention, no matter by whom written or the nature of the complaint involved, and we endeavor in each case to have a representative of the department call upon the complainant and adjust the matter if it is within his power to do so. We take the position that the section of road in front of any man's house is to him the most important highway in the state and his opinion of the work performed by the department throughout the state is based to a great extent upon the manner in which his special case is handled. A record of these complaints is kept in the main office according to route and county, and, provided further complaints are received from other sources, an inspection and usually a call upon the complainants is made by a representative from the main office.

In order that our records may be complete and aid in centralized control, a series of reports, statements and charts have been developed covering each phase of the work, included among which is a weekly report made by the superintendents showing the roads covered by them during the past week and their condition. The surfacing and surface treatment reports are compiled in the field and forwarded to the main office. They show the amount of each particular type of work completed and from the information furnished a chart is compiled each week.

Snow Removal.—Pennsylvania has organized its forces and equipment for snow removal on approximately 1,100 miles of improved main arteries. These roads are kept open for all kinds of traffic throughout the winter. This snow removal work is handled through the co-operation of the various local offices of the United States Weather Bureau. Postcard reports, showing the condition of each road at five o'clock in the evening, are mailed each day simultaneously to the Weather Bureau meteorologists and the main office, the weather bureaus furnishing this information to the newspapers. Prior to the receipt of this postcard we assume that the road is open unless advised by wire to the contrary.

Standardization of Practice and Methods.—To standardize practices and methods, we have two maintenance inspectors

They make periodic inspection of all state highway routes, submitting a report of their condition to the main office, together with their recommendations. They are usually accompanied on an inspection trip by the engineer of the district, or his representative, to whom is given instructions and advice on the handling of their maintenance work. These periodical reports show the progress of each job.

The field operations are directly in charge of the district engineer who has three or more counties with usually three superintendents. Each district engineer has an office and is directly responsible for all construction and maintenance in his district. The superintendent, who also has an office and staff, devotes his entire time to the details of maintenance work. He selects and makes requisition for the purchase of all materials and supplies, employs all labor and is directly responsible for the economical maintenance and operation of all equipment.

The success of the organization is dependent to a great extent upon the continuous and economical operation of equipment. We have worked out a complete equipment operation control chart. This is followed up closely by the main office and when any equipment is idle without any explanation it is immediately taken up with the superintendent in charge.

The field control of funds, as referred to in the early part of this paper, is entirely in the hands of the district engineer.

Each foreman, caretaker and truck driver must have an appointment card approved by the district engineer which shows his name, by whom he was recommended, amount he is to be paid and date the appointment is to become effective. This is forwarded in triplicate to the Maintenance Division for approval, one copy of which goes to the Payroll Bureau of the Auditing Division for its guidance in passing pay rolls and one copy each to the district engineer and superintendent showing that the appointment has been approved. In the case of truck drivers, the superintendent submits a questionnaire with the appointment card. The questionnaire gives details as to the ability of the applicant to operate motor equipment, and is approved by the equipment engineer before the man takes charge of department equipment.

Methods of Maintenance Forces. The actual operation of the maintenance division is as closely interlocked with the organization as the organization is with the financing. It is very hard to differentiate in some cases between the two. We will assume that the organization has been determined upon and the actual operation is to take effect. The Maintenance Division selects the means to be employed in the repair or reconstruction of the roads, the development of standards and the preparation of instructions as to how to apply these standards and methods.

We have spoken several times regarding the necessity of planning and scheduling your work. Periodic inspection is also necessary and a real system of followup is very important if the best results are to be obtained. Of course, the principal problem for the field to solve is to have a thorough understanding of their roads, type and behavior under various conditions.

In the natural physical conditions to be overcome the study of drainage and local materials is most important. Our plan from the first has been to repair a road with material in harmony with its original type, that is an earth road with earth, a gravel road with gravel, a stone road with stone.

In the resurfacing of the waterbound macadam type, we have always advocated the use of large stone, varying in size from 1½ to 3½ in.; this stone must be thoroughly locked by the roller before the application of the screenings, screenings to be from 0 to ¾ in. and well broomed in with push brooms in order to get a uniform coating, no water to be used until after the voids in the stone have been filled with screenings. The use of a templet upon the grade and then upon the finished road is advocated. A straight edge should be used longitudinally. There should be just sufficient screenings to properly bind the road without leaving a cake on the top.

On newly built macadam roads, we believe the first surface treatment should be a low viscosity tar of about ½ gal. applied to each square yard. As much of the success of future applications depends upon the initial treatment, great care must be exercised to see that the road is thoroughly cleaned especially along the edges in order to insure a maximum penetration. The second application may be either a medium viscosity tar or asphalt, applying .25 to .3 gal. per square yard, as the road requires, using from 20 to 25 lb. of ¼ in. to [illegible] in. chips to the square yard. A road thus treated should not require another treatment for at least a year, but we find that we obtain much better results if we treat our roads successively for the first three years, after which we may be able to omit the treatment for several seasons. We have obtained good results by placing a third treatment of hot asphalt having an asphaltic content of 88 to 95 at 100 penetration, or a consistency (float test) of approximately 150 sec. at 50° C. Usually from .15 to .25 a gal. is applied per square yard, which requires from 30 to 40 lb. of covering material.

One very important function of the Maintenance Department is to make the roads as safe as possible for traffic. With this idea in view we have cooperated with the railroads in the erection of advance warning signs at all grade crossings, which signs are placed 300 ft. from crossing.

Standard danger and direction signs are used by the Department. These are constructed of cast iron and the base is placed in concrete. To augment the direction signs we whitewash telephone poles to a height of 6 ft. from the ground, which not alone directs the traveler to his destination but is of considerable advantage in traveling at night.

Road Side Maintenance.—Maintenance work does not alone mean the proper patching and maintenance of the surface but also the proper care within the right-of-way lines. With this idea in view, we have insisted that superintendents place all their patching material in long piles outside of the ditch lines, and that all brush should be cut periodicaly, piled and burned. With this same idea in mind, where bituminous material is used in the patching of roads, we have constructed drum racks. It not only makes a much neater appearance, but saves the caretakers considerable time in drawing out the materials.

A checkerboard marking is used on abutments and wing walls of dangerous undergrade crossings, which shows up to great advantage as does also the center marking which has been adopted for divisional traffic lines on sharp curves.

The organization and operation of the Maintenance Division of any State can be arranged with a little modification, and the addition or subtraction of units, to conform with the above outline. The principle has been found correct. The changes on account of legal difficulties or geographical difference can be readily made. From the head of the Department to the humblest workman, there must be no break in the organization, no conflicting division of authority, no deliberation of boards before action can be taken. It must work straight to the point, with but one object. Maintenance is as true an investment as construction. The smoothness requisite to good results is only arrived at after careful study of the problem.

Engineers Club Organized at New Orleans.—The engineers of New Orleans have organized an Engineers Club, the present purpose of which is to hold luncheons monthly for the purpose of developing a fraternal spirit among the engineers of that vicinity. The meetings are to be held on the third Monday of each month. At the first meeting in February there were 65 members present representing the following: American Society of Civil Engineers, Louisiana Engineering Society, American Society of Mechanical Engineers, American Chemical Society, American Association of Engineers. For the ensuing year the following officers were elected: President, Ole K. Olsen; vice-president, J. F. Coleman; secretary, F. A. Muth; treasurer, J. F. Villavasso.

Automobile Registration in Pennsylvania.—A comparison of automobile registration in Pennsylvania in 1921 and 1922, as of Feb. 6, shows the following:

	1922	1921
Passenger cars	[illegible]	[illegible]
Commercial Vehicles	[illegible]	[illegible]
Motorcycles	[illegible]	[illegible]

At the close of 1921 the registration of passenger cars totalled 632,541, so that over 200,000 cars remain unregistered. These cars are presumed by the State Highway Department to have been laid up for the winter, inasmuch as few cases are reported where drivers are operating with 1921 license tags.

The Bates Experimental Road of Illinois

Results of Research on Construction snd Subsequent Behavior of Road Summarized in Paper Presented Jan. 19, at Annual Meeting of American Road Builders Association

By CLIFFORD OLDER,
Chief H[illegible], Division of Highways, State of Illinois

Early in 1920, Governor Frank O. Lowden in conference with Frank I. Bennett, Director of the Department of Public Works and Buildings; S. E. Bradt, State Superintendent of Highways, and the writer, decided that the State of Illinois was justified in undertaking the construction of an experimental road of unprecedented magnitude. The result was the construction of the Bates Experimental Road. The Bates road was started in 1920 under Governor Lowden's administration and was finished in 1921. The completion of the project and the continuance of investigations in connection therewith were heartily endorsed by Governor Small.

Subgrade Moisture.—For more than a year subgrade samples for the determination of moisture content have been collected periodically from several hundred stations located along the Bates road and along about 60 miles of paved highways adjacent to Springfield.

In Fig. 1 is platted the moisture content curve of the subgrade of the Bates road. The moisture content is expressed as a percentage of the dry weight of the soil. The soil in this case is the brown silt loam of the Mississippi Valley Corn Belt. It is a finely divided material that ordinarily would be called a clay soil. The sampling stations in the Bates road were established in position such that the results would show any variation which might occur in the moisture content, due to the proximity of the station to the edge of the pavement, to cracks and to joints, as well as in areas as far removed from such features as possible. It soon developed, however, that the moisture content of the subgrade soil in proximity to edges and cracks was at no time materially different from that observed elsewhere. This conclusion has been checked from time to time up to the present date. This condition might not prevail in localities where prolonged rainless seasons occur. A further observation of interest in this connection is that at the point in the Bates road where a tile drain with a cinder backfill was laid 30 in. below each edge of the pavement for a distance of 200 ft., the moisture samples show no variations from those obtained elsewhere.

About 8 miles from the Bates road a section of pavement, 1,000 ft. long, was selected for a drainage experiment. Tile drains were laid immediately under each edge of the pavement a depth of 36 in. below the bottom of the slab. The trenches were back filled with cinders and sampling stations were established throughout the 1000 ft. The moisture content of the soil under this section has been uniformly lower than that under the Bates road. However, it is believed that this result is due to the difference in the character of the subgrade soil (which is a yellow clay) rather than to the effect of the tile drainage. This conclusion was deducted from the fact that moisture samples taken from the subgrade of undrained sections, where the soil is of the same nature, also shows a lower moisture content than that under the Bates road and approximately the same as that of the tiled sections. A sufficient number of samples from undrained subgrades having soil of this character has not as yet been tested to make this condition positive.

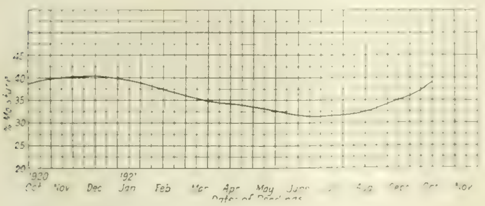


Fig. 1.—Subgrade Moisture Indications.

Prof. Eno, in a paper read before the 1921 American Road Builders' Convention at Chicago, brought out the fact that certain clay soils of Ohio when moulded in a moist condition resisted to a marked extent the further absorption of moisture, while the same soils after having been dried, disintegrated rapidly when placed in water and absorbed a much larger volume of water in a short period of time. It seems probable that this is true of many if not all clay soils; and no doubt accounts for the rapid saturation of the Bates road subgrade in the fall of 1920, as a large portion of the pavement was laid on an air-dry subgrade. Within three days after the fall rains started the subgrade was found to contain the high percentage of moisture indicated in this diagram. It is to be noted that more than five months during the summer of 1921 the moisture content varied less than 5 per cent, although frequent rains occurred. At the present time the moisture has again reached a high figure, but the increase has been gradual.

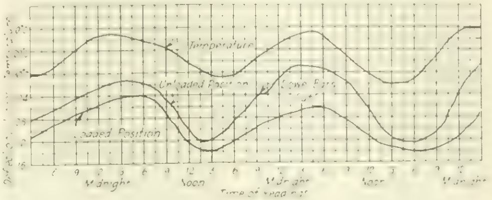


Fig. 2.—Results of Application of 6,000 Lb. Load on Corner of Slab.

In order to determine the possible rate of saturation of the subgrade from the edges to the center, in July a trench was cut along the edge of the pavement and kept filled with water for some days. At first this trench was cut immediately against the edge of the slab, but as the warping of the pavement due to changes in temperature, immediately permitted sheets of water to flow under the pavement it was impossible to obtain the desired results. Later, a trench about 1 ft. from the edge of the pavement was cut at a different point, leaving the shoulder undisturbed between the edge of the trench and slab. This trench was kept filled with water for a period of three weeks. Although the nearest sampling stations were only 30 in. from the edge of the trench, the moisture content of the subgrade at these stations showed no increase and no variation from that at other points under the pavement.

In order to ascertain whether or not the freezing of soil would render it more susceptible to saturation, a number of blocks of the subgrade were cut out very carefully so as not to disturb the natural compaction, then frozen, and after having been thawed out were immersed in water. After freezing most of the blocks fell to pieces upon immersion. Samples that had not been frozen remained practically intact and absorbed moisture slowly. The samples which had been frozen and then immersed in water absorbed moisture at a much more rapid rate. Typical of these experiments, four blocks, when taken from the subgrade showed an average moisture content of 28 per cent; after immersion for 20 hours, the moisture content was increased to 33 per cent or an increase of 5 per cent. Another set of four blocks, having the same initial moisture content, after having been frozen for 6 hours and then immersed in water for 24 hours, showed an average moisture content of 42 per cent or an increase of 14 per cent. From the results of these tests, it seems altogether probable that although a clay subgrade may resist, markedly, saturation from an occasional rainfall, yet the same soil may quickly become saturated after a freeze. An examination of the curve, Fig. 1, shows further that although the moisture content has not increased rapidly, yet a high degree of saturation has again been reached, although we have had no freezing weather.

Subgrade Bearing Power.—Much time has been spent in an effort to ascertain the factors having influence on the sup-bearing capacity of subgrade soils. Believing that soils might behave differently under repeated loads as compared with loads applied but once, an apparatus was devised and perfected, by means of which loads up to 40 lb. per square inch could be repeatedly applied on subgrade soils in place. This apparatus was briefly described in an article which appeared in Public Roads, Volume 4 No. 5. The results of its use up to the present time have not been entirely satisfactory, owing to the apparent difficulty in securing a perfect contact of the plunger with the subgrade soil before a load is applied. No process yet tried has eliminated an initial deformation under a light load considerably greater than that obtained under the same load on subsequent applications. However, the use of this apparatus points already toward the conclusion that a soil having a fixed moisture content, may under repeated loads have a fairly definite elastic limit. For example, on a clay soil subgrade a load of 5 lb. per square inch was applied approximately 1,000 times. After the initial deformation, caused by the first few applications of the load, subsequent applications produced a definite deformation under each repetition with complete recovery as the load was released. The load was then increased to 25 lb. per square inch with the result that progressive deformation continued until a total penetration of 0.25 in. occurred when the test was discontinued. The general behavior of subgrade soils as determined on small areas by this machine was closely confirmed by loading concrete slabs having areas of several square feet which were cast on the same subgrade. These slabs were loaded repeatedly by means of an hydraulic jack. Even in the case of these slabs which were presumably in perfect contact with an undisturbed subgrade the first few light loads caused permanent depressions. In this connection it should be understood, however, that different points on the same subgrade soil, although having the same moisture content, did not exhibit uniform results. This perhaps is partially due to lack of perfect contact between the loaded slab and the subgrade; but most likely to inequalities in the compaction of the subgrade soil. It remains to be determined whether or not a subgrade soil at all seasons of the year, or at seasons when the greatest degree of saturation prevails, may be counted upon to exhibit elastic resistance to deformation when subjected to pressures as great as the lowest that may practically be obtained with economic pavement designs. It is certain that this resistance for the Illinois Corn Belt soil containing at times 40 per cent moisture is very low—probably less than 1 lb. per square inch. For the good of the cause we hope this condition is peculiar to Illinois, but we doubt it.

Comparatively little work has been done on soils other than the brown silt loam of the Mississippi Valley Corn Belt. A number of observations, however, on a very finely divided sandy soil shows the same general characteristics with no marked variation either as regards bearing power or saturation tendencies; but this soil contains a considerable portion of clay and might be expected to exhibit materially different characteristics from coarse and clean sand or gravel.

Efforts have been made to determine the bearing capacity of subgrade soils in place when highly saturated; but inasmuch as the bearing power determinator was not perfected until the moisture content of all subgrades available had dropped below 25 per cent and as attempts at artificial saturation of the soils in place failed, no material results have been obtained up to the present time. As the Bates road subgrade survey indicates that Illinois is again about saturated we now hope to obtain the desired information.

Subgrade Uniformity. There were installed in the Bates road many subgrade cylinders each having a brass disk in contact with the subgrade and a reference plug screwed in the cylinder in such a manner that measurements taken from the plug to the brass disk would show the relative position of the subgrade and the pavement slab at any time. (For detailed description see Public Roads, Vol 4, No. 5). Throughout the year readings have been taken once each week. The results of these observations are of considerable interest. They show distinctly a periodic separation of the pavement slab and the subgrade due to warping of the slab under temperature changes. They show also, to a very marked extent erratic variations due in all probability to uneven settlements of the subgrade. Some of these brass disks show a separation of the slab and the subgrade as much as ½ in. over areas of considerable magnitude. Just how far these areas extend it is impossible to determine, as the spacing of the cylinders is not close enough. At practically all of the observation cylinders, a separation of the subgrade and the slab has occurred at one time or another. This separation by no means can be entirely accounted for by the warping of the slab. The erratic movement of the brass disks relative to the slab would lead us to believe that not only is the slab itself constantly warping, but that the subgrade also, is not stable even although there be no traffic on the road. As the moisture content of the subgrade was fairly uniform for several months it seems hardly likely that this is due entirely to a changing moisture condition. It may be due to changes of temperature, but it would seem more probable that the operations of grading, plowing, harrowing and re-rolling the subgrade did not produce a uniform compaction. No doubt voids occurred after harrowing and rolling, and the slacking or breaking down of the soil in a non-uniform manner under different portions of the pavements probably accounts for a large portion of the erratic subgrade movement. In this connection, methods used in preparing the subgrade may be of interest. No heavy grades occur throughout the two miles section; the deepest fill is about 2 ft., and deepest cut about 18 in. After the rough grading was done the entire subgrade was plowed, harrowed, rolled and wetted the day before the pavement was laid. It is not believed that any economically practical method of compacting a subgrade may be applied with reasonable economy to secure absolutely uniform results.

Frost Action. Observations of frost heaving on the Bates road were made during the winter of 1920-1921. After these observations were started only one period of low temperature occurred, at which time the ground became frozen in the open fields and the shoulders of the road to a depth of about 8 in. Practice levels taken from bench marks, carefully protected from frost action, showed a heaving or lifting of the edges of the slab throughout the entire length of the road at a much more rapid rate than at the center. On sections where a longitudinal joint was provided, the edges of the pavement slabs lifted on an average of about ¾ in., while during the same period the center lifted but an average of about ¼ in. Many sections not provided with longitudinal joints showed approximately the same behavior. All such sections when examined in the spring were found to be cracked longitudinally. A few sections lifted at the edges about ¾ in. and at the center about ½ in.; these sections showed no discernible longitudinal cracks when examined in the spring. As no loads were permitted on the road during this period, it is evident that the longitudinal cracks were caused by the breaking of the slab under dead load while supported at or near the edges only. If the heaving of the soil due to freezing is universally more rapid under the edges of the pavement than elsewhere, it would appear impossible to avoid the longitudinal breaking of wide slabs, where freezing temperatures occur, especially under heavy traffic. Mathematical analyses indicate that it is likely to be economically impracticable to design wide slabs of sufficient strength to avoid breaking longitudinally when the edges only are supported; hence the present Illinois design provides for a longitudinal joint in order that erratic longitudinal cracks may be avoided as far as possible.

Temperature Effects. The lateral and longitudinal expansion of a pavement slab, due to temperature and moisture changes, is well appreciated. It is doubtful if lateral contraction or expansion is responsible for longitudinal cracks. It is more probable that such cracks are due to freezing subgrades or perhaps to conditions of support caused by the warping of the slab. It seems altogether likely that contraction due to temperature or moisture changes accounts for at least the first transverse cracks that appear in all concrete slabs.

In the fall of 1920 while attempting to take strain gauge and deflection measurements on concrete slabs under load, the results obtained at first were so erratic as to be useless unless the cause for the erratic behavior could be determined. We undertook one series of tests to determine whether or not the subgrade under a corner of a slab would be compressed under repeated loads to such an extent as to afford no definite support to the pavement. With the apparatus at hand it was impossible to repeat the loads rapidly and in order to avoid possible subgrade recovery during periods of rest, the loads were repeated continuously for periods of 48 hours. It was then discovered by an exam ination of the results that at night the slab corner under load might be at a higher elevation than the unloaded corner during the day. We have no knowledge of any previously conducted research work indicative of this important feature.

Figure 2 shows the air temperature, and the vertical movement of the corner of a 9-in. plain concrete slab loaded and unloaded. This diagram is typical of several hundred, all of which show the same characteristics. Hourly elevation readings to thousandths of an inch were taken by means of Ames Dials. The 6,000 lb. load was applied to the corner for three minutes each hour. Under this load the computed fibre stress in the slab was 220 lb per square inch Note that for about ⅔ of the 54-hour period the 3 ton load did not depress the corner to its unloaded afternoon position. It is obvious that the suggrade offered but little if any support for ⅔ of the time.

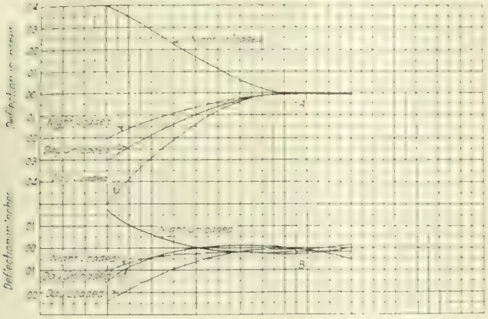


Fig. 3.—Curviture of 7 In. Slab.

Figure 3 shows the curvature of a 7-in. slab on a line bisecting the corner angle. The upper solid line, diagram A, shows the upward warped position of the surface of the slab along a 45° line from the corner to the center of the pavement. The upper dashed line shows the position of the slab while a load of 6,000 lb. was applied on an area of 2 sq. in. at the corner. The lower solid line shows the position of the unloaded slab at the point of maximum downward deflection. The lower dashed line shows the position of the slab under the 6,000-lb. load when applied during the day. It is obvious that the slab corner acted purely as a cantilever in supporting the night load. It is also obvious that, as the increased deflection was not as great when the load was applied during the day as when applied at night, subgrade support had some influence on the amount of deflection. The computed fibre stress of the concrete, considering the corner as a cantilever under the night load, amounts to 368 lb. per square inch, which is certainly not too low for the working stress of plain concrete. It is obvious that a much greater load with a correspondingly high fibre stress would be required to deflect the corner to contract with the subgrade at night.

Diagram B, Fig. 3, shows the effect under similar conditions of a longitudinal crack or joint. In such case it is evident that the warping effect does not ordinarily pivot about the center of the full width of the slab, but probably approximately about the center of the half slab as defined by the longitudinal joint. It is of interest to note, however, that even in this case the upward warping of the slab due to temperature effects was greater than the downward deflection of the slab under the 6,000-lb. load producing a fibre stress of 368 lb. per square inch.

That curling of the edges of an 18-ft. concrete slab may be sufficient to render the most perfect of subgrades ineffective under the edges of the slab may readily be determined without the aid of accurate measuring devices. To visualize this condition the photographs—Fig. 4—were made.

Figure 4-A shows the edge of an 8-in. pavement slab and subgrade below. The white card on the left is rigidly attached to the slab. The card at the right is fixed to the subgrade at some distance below the base of the pavement. The black line was drawn across the two cards at mid-day while the sun was shining.

Figure 4-B, taken at midnight, shows a distinct crack in the earth subgrade a short distance below the bottom of the pavement, and shows the offset in the line caused by the upward movement of the slab. A load of 4 tons on the edge of the pavement failed to close the offset or the visible crack in the subgrade.

By means of the brass disks of subgrade cylinders located in a row across the pavement slab, the relative movement of the slab and the subgrade was confirmed. In many cases these measurements indicated positively that the downward curling of the edges during the day lifts the center of an unbroken slab entirely free from the subgrade near the center. They indicate also a permanent depression of the subgrade at the edges of the pavement under this condition, although a partial recovery occurs as the edges curl up at night. The warping phenomenen is, of course, caused by the more rapid heating and cooling and consequent expansion and contraction of the upper layers of the slab. The warping effect occurs much more rapidly on clear, sunny days than when the sky is obscured by clouds. On sunny days the effect of passing clouds may be noticed in the reading of Ames Dials set for these observations. Wetting the surface of the pavement has a similar effect. Monolithic brick pavements exhibit practically the same degree of warping as concrete slabs. The effect is much reduced when a bituminous concrete surface is applied, as might be expected. It is similarly reduced when a brick wearing surface having a bituminous joint filler is used on a concrete base. Figure 5 shows the edge movement of various slabs. All readings were taken practically simultaneously for 24 hours.

Special attention is called to the slight warping of slabs having plastic surfacing materials of considerable thickness. Such surfacings no doubt tend greatly to reduce the ordinary range of temperature between the upper and lower surfaces of the rigid base, thus materially diminishing the warping of the slab. Under load, pavements of this character would no doubt receive material support from rigid subgrades or subgrades having a high elastic resistance, even under night traffic. The fact that clay subgrades are more than likely to become saturated at times, and when in such condition have very low supporting power, should not be overlooked.

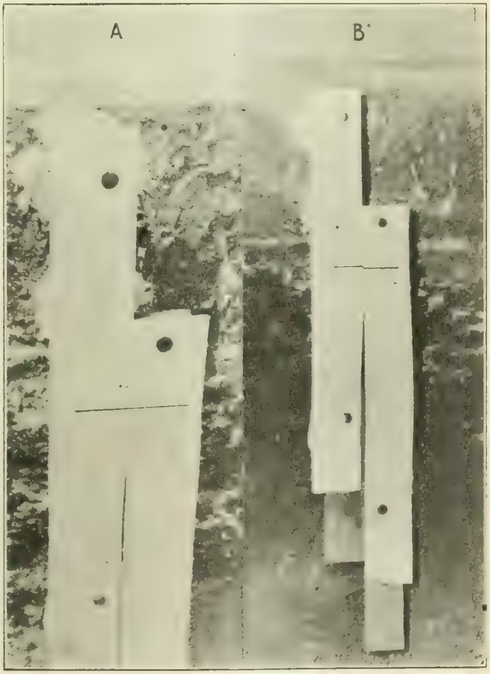


Fig. 4.

Attention is also called to the comparatively small warping of the concrete slag having a longitudinal joint. Pave-should be constructed may also be expected to receive some edge support from good subgrades under night as well as day traffic.

It is evident that the warping of these slabs away from the subgrade provides open channels for the free passage of surface water to all parts of the subgrade. Not only was this in evidence when the ditch, mentioned before, was cut along the edge of the pavement, but has been observed many times during the last twelve months. Throughout the year with distressing regularity free water was found in the subgrade 24 hours after heavy rains. Further, our latest observations indicate even greater warping effects during the coldest weather that has prevailed this fall than appeared in July and August.

It seems entirely possible that water from rains or melting snow that finds its way under the edges of a slab as it curls up in the early part of the night, later freezes, thus forming a harder support for the edges and causes an excessive lifting of the entire slab the next day unless it breaks longitudinally under its own weight.

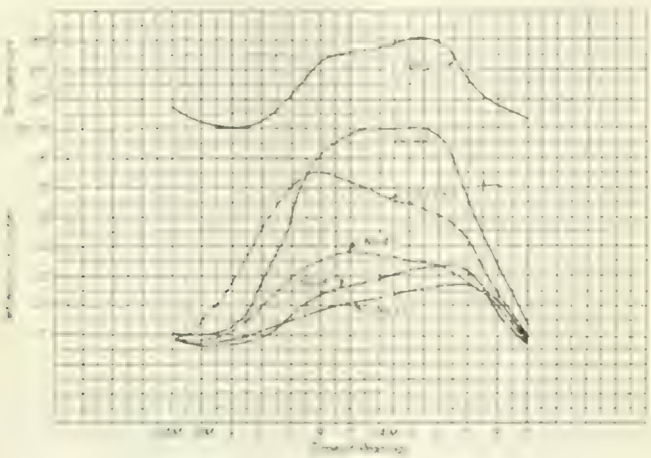


Fig. 5.—Curling Action of Slabs

No. [illegible] No. [illegible] W. C. [illegible] 1:2:3½ base. No. [illegible] vertical and longitudinal [illegible] No. [illegible] Topeka top on 1:2:3½ base. No. [illegible] 1:2:3½ base.

It also seems probable that the formation of ice under the edges at night and under the middle portion during the day is a more reasonable explanation of the presence of layers of ice which have been observed under pavement slabs, than the theory of capillary action.

Impact. Specifications of the Illinois Division of Highways provide that the variation of the elevation of the surface of concrete pavements shall not exceed ¼ in. Some difficulty has been encountered in securing this degree of smoothness, especially on grades of more than 2 or 3 per cent and on curves. However, the variations are not abrupt and a constant improvement is being obtained. It is believed that the above variation may be reduced materially by more careful construction methods, perhaps aided by hitherto untried equipment. By careful maintenance methods it is believed that the application of crack filler can easily be handled in such manner as to avoid any material differences in elevation from this source. We have as yet not attempted to devise an accurate means for determining the value of impact on average road surfaces. We do have some data which may be taken to indicate that possibly this matter is not of extreme importance—for example, Ames Dials have been placed so as to read deflection of the pavement slab, these dials being carried on independent supports. Trucks have been operated past these dials at speeds up to 20 miles per hour. The trucks were directed so that the rear wheels would pass as close to the dials as might be possible. During the approach and passage of the load the hand on the dial was observed very carefully. These investigations were carried out on uncracked pavement sections of ordinary smoothness, adjacent to cracks having the usual joint filler, adjacent to open joints, etc., yet no movement of the hand of the dial has been observed which would indicate more than a gradual and steady application and release of the load as the truck passed. It is possible that sudden movements occurred which were not observed, but this seems unlikely as a blow of a sledge could easily be detected. Further, in the machine devised to determine the effect of repeated loads on plain concrete beams each repetition of the load occupies one-tenth of a second. In this case the deflection of the beam, as shown by the hand of an Ames Dial, is easily distinguished and its magnitude can accurately be determined. These observations are, of course, but indications of what may occur, but point to the great importance of the development of some means for conclusively setting at rest all doubts as to impact effects caused by roughness of the average pavement slab as now constructed.

All Cracks Not Serious. It may be assumed that a pavement need not be so designed as to avoid all possible cracks or even all load breaks. The usefulness of a pavement is destroyed only when it becomes so broken or disintegrated that it no longer affords a smooth and comparatively unyielding surface. Transverse cracks or joints in rigid pavement slabs may be accepted as inevitable. Illinois for about 6 years has not provided for transverse joints, yet possibly with the exception of a few roads carrying very heavy trucks and in one unexplained instance, transverse cracks do not average less than about [illegible] apart. This average covers pavements more than a year old. On two stretches of concrete road in Cook County subjected to very heavy truck traffic, transverse cracks are much more frequent regardless of the character of the subgrade soil or drainage, and longitudinal cracks occur throughout. It seems quite possible that the frequency of the cracks in these sections may be due to the existence at one time or another of comparatively large areas where the subgrade was not in contact with the road slab, as was found in the case of the Bates road, and represent load breaks. These sections, however, although they are in the main broken up into pieces of from 3 or 4 to perhaps 60 sq. yd. in area, are still rendering practically unimpaired service to traffic. While the breaking of the pavement into slabs of large area may be detrimental only on account of appearance and slightly increased maintenance costs, yet the breaking down and pulverizing of comparatively small areas at corners and the consequent reconstruction at these places causes serious traffic delays as well as expense.

Allowable Stress in Plain Concrete.—Whatever design formulae are eventually developed, it becomes of great importance to determine what may be a safe working load for plain concrete in tension. An apparatus was outlined by the writer and built in accordance with designs made by Mr. Clemmer, our testing engineer, for determining the effect of repeated loads on the transverse strength of plain concrete beams. This apparatus consists of a pair of automobile wheels carried on a horizontal axle which are revolved around a circular track by means of a vertical shaft carrying a pulley operated by a belt from a motor. Load boxes are placed on the axle so that the weight carried by the wheels may be varied as desired. Test specimens consist of 6 in. x 6 in. plain concrete beams, radiating as the spokes of a wheel and cantilevered from a central support. Between the beams, but separated therefrom by ¼ in. openings, are blocks of concrete flush with the beams so that a smooth track is provided for the passage of the wheels. Seven beams are placed in the machine for each test. The apparatus is so arranged that when any beam breaks a switch is thrown and the motor stopped. By this means the fatigue machine may be operated day and night regardless of the presence of the observer. This apparatus provides also the advantage of having beam ends of sufficient length, after rupture in the fatigue machine, for modulus of rupture determinations in a Universal Testing Machine. As the beams invariably break over the support the length of the cantilever end is sufficient to make two modulus of rupture determinations on span lengths of 12 in. This is of importance, as the determination of modulus of rupture of similar beams, presumably of the same character as those subjected to repeated loads, is by no means a safe guide as to the strength of the beams subjected to the repeated loads.

The first set of beams were subjected to more than 1,130,000 repetitions of a load which was presumed to be 75 per cent of modulus of rupture of the concrete, but which later proved to be but about 37 per cent. As none of the beams failed, the load was increased to about 53 per cent, when one beam broke at 43,174 loads. It was then found that the modulus of rupture of this beam was about 1,000 lb. per square inch. Another interesting fact that developed was that five other beams of the same mix, and cast at the same time as the original seven, broke under an average of 60,000 repetitions of the same load when placed in the space left vacant by the breaking of the first beam of the original seven, while the remaining original beams remained unbroken under 214,000 applications of this load. The load was then increased to about 60 per cent, when all but one broke at an average of about 40,000 loads. This would indicate the possibility that a large number of repetitions of a light load may have a beneficial effect on the transverse strength of plain concrete.

Two additional sets of beams have been broken, 12 beams in each set. In order to avoid the possibility of the effect of initial light loads, before the machine was started two beams cast at the same time were placed in the testing machine and modulus of rupture determined. The load on the wheels for the first additional set was then proportioned to approximately 70 per cent of the modulus of rupture. Under this load all of the new set of beams broke under repetitions varying from a few hundred to a few thousand applications.

An additional set of 12 beams is now being tested with a load on the wheels which will give a stress approximately equal to 60 per cent of the modulus of rupture. This set of beams is carrying a considerable higher number of repetitions than was the case where beams were loaded 70 per cent of modulus of rupture. They are, however, breaking under number of repetitions much less than might be expected during a year's time on a road slab carrying traffic of considerable intensity. From the behavior of the second and third sets of beams there is good reason to suppose that the per cent of the ultimate load that may be applied indefinitely may be affected materially by the age of the beams when first subjected to repeated loads. The tests now under way, therefore, are all being made on beams 28 days old when placed in the machine. From the results so far obtained it would seem probable that plain concrete in transverse bending may be able to withstand an indefinite number of repeated loads provided the stress is something less than 50 per cent of the modulus of rupture.

Position of Loads for Maximum Stresses.—Figure 6 indicates conditions which may apply along the edges of a pavement slab. Curve a represents the deflection readings of an Ames Dial placed at the edge of the pavement during the passage of a 4-ton wheel load along the edge of the slab as close to the dial as feasible. The dial in this case was placed at some distance from the nearest transverse crack. It is of interest to note the shape of the curve showing the deflection of the edge at the dial as the wheel passed and the total amount of this deflection. Curve b (Fig. 6) shows the deflection when two dials were placed on the corner formed by a transverse crack. In this case the crack was very fine, the observations having been made during a period of high summer temperature when the slab was expanded and apparently all cracks closed very tightly. Note that the total deflection is much greater than shown in Curve a (Fig. 6), although it is apparent that the closed crack prevented each corner from acting independently. Curve c (Fig. 6) shows a similar condition in which, although the crack was open, short dowel bars passed across it. Note that the deflection is approximately the same as that which occurred at the closed crack. Curve d (Fig. 6) shows the very marked effect occasioned by an open crack or joint with no dowel bar or other means for causing both corners to act together. Deflections of the center of a slab under load were too small to be platted to this scale. While deflections only are platted in these diagrams, yet strain gauge measurements show the same proportionate results. As stresses are in proportion to strains the position of loads to produce maximum slab stresses are easily apparent from these diagrams. All of these deflections are platted from observations on slabs of the same thickness and taken during the night when the edges of the pavement were not in contact with the subgrade.

The advantage of providing means for causing adjacent corners to act together in supporting concentrated loads is also unmistakably illustrated by Fig. 2. The readings from which these corners were platted were taken on a corner formed by a construction joint entirely open to the subgrade except that short dowel bars were in place across the joint. The load was imposed upon the corner on which these deflections were taken. Note that during the first night while the dowel bars were in place the maximum deflection under load was only about 0.03 in. The dowel bars were cut at about 9 o'clock the next night, with the result that the maximum deflection under load increased to about 0.08 in.

The Design of Rigid Pavements. In the light of the foregoing observations, the possibility of applying rational designing methods to rigid slabs seems to be within reach.

It is, of course, fundamental that in order that any structure may rationally be designed the maximum loads to which it will be subjected must be known. The position and frequency of the application of the loads must also be known or assumed to be such as to produce the maximum destructive effect on the structure. It would also seem to be of prime importance that the actual impact factor of highway wheel loads on pavements constructed as smoothly as may be practical under modern methods should be determined.

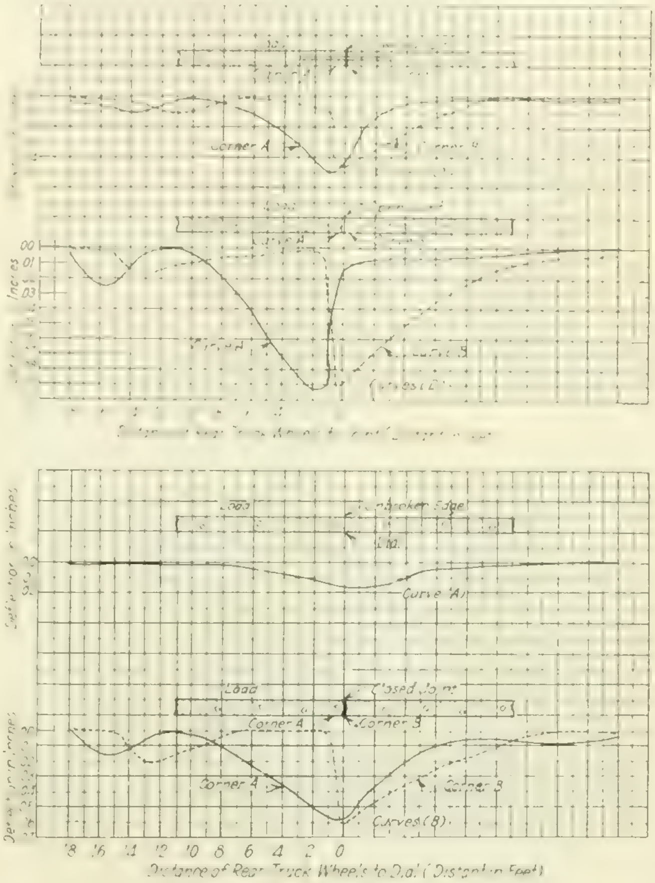


Fig. 6.—Deflections Under Moving Load.

Until exhaustive investigations can be made to determine the economic truck unit, we are faced with the problem of controlling maximum wheel loads by legislation based upon arbitrary judgment. The Illinois law provides for a maximum axle load of 16,000 lb. This may be assumed to correspond with an 8,000 lb. wheel load. As to the frequency of the passage of such wheel loads over pavement slabs, it is our observation that on trunk line roads in the near future great numbers of trucks, loaded to the limit prescribed by law, may be expected. Allowable stresses must also be fixed and the subgrade support duly considered.

In the light of what we believe to be conclusive evidence that an uncovered rigid slab may become warped by temperature effects so that it will, for from 8 to 12 hours out of every 24, be completely unsupported along the edges by even the best of subgrades, and considering the probability that at least on clay subgrades at certain seasons of the year the soil may have an exceedingly low supporting capacity, and further considering the fact that during the period of greatest subgrade saturation which no doubt occurs immediately upon the thawing out of the ground in the spring when low temperatures prevail, the cracks are open to the maximum amount, it would seem that to resist local breaks it is necessary to design the corners of the pavement as unsupported cantilevers. Unbroken edges are far less susceptible to traffic breaks than corners, as is clearly illustrated by Fig. 6.

It is the writer's firm belief that if the thickness of the pavement be designed to carry the maximum load at the corners in accordance with the formula $d = \sqrt{\frac{3W}{S}}$ which formula gives conditions at unsupported right-angled corners, the remainder of the pavement will be well able to carry the same load without breaks which would damage its usefulness as a pavement surface.

The derivation of this formula is as follows: Assume load W applied at corner b = Moment arm to section A, B.

Then if A B makes a 45° angle with the edge of the slab A B = 2 b

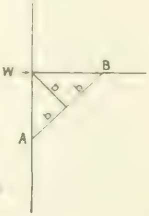
M = W b

S = allowable tensil stress

I = moment of inertia of stressed

$$\text{section} = \frac{2bd^3}{12}$$

$$C = \frac{d}{2}$$



Substituting these value in the formula $S = \frac{Mc}{I}$ it reduces to $S = \frac{3W}{d^2}$ or $d = \sqrt{\frac{3W}{S}}$.

If means could be found to make both corners act together by placing longitudinal shear bars along the edges of the pavement or by some other means and the corner weakness thus be reduced by one-half, the design formula $d = \sqrt{\frac{1\frac{1}{2}W}{S}}$ could be used with a reasonable degree of safety. In order that all possible corners might be taken care of it is believed that the position of the longitudinal crack should be controlled by constructing a longitudinal joint and the adjacent slabs held in close contact by transverse tie bars. The interior corners, being held in close contact along the longitudinal joint by the transverse tie bars, should be fully as safe as the edge corners. The shear bars along the edges should also be continuous in order to take care of corners formed by transverse cracks regardless of their position.

Figure 7 shows the thickness of slab required if designed in accordance with the formulas heretofore given, assuming a safe working stress for 1:2:3½ concrete in tension of 200 lb. per square inch. The upper line is platted from the formula $d = \sqrt{\frac{3W}{S}}$ and the lower line the formula $d = \sqrt{\frac{1\frac{1}{2}W}{S}}$. The result of our fatigue tests although not yet complete seems to indicate that a working stress higher than 200 lb. per square inch may be safe for concrete of the quality ordinarily used in road construction. The data so far obtained indicate that a single ¾-in. shear bar placed along each edge of the pavement may not be 100 per cent efficient in making both corners act equally under a load applied to one corner only. This may be due to the use of a heavy coat of asphalt on the bar, which has been the practice up to date. The yielding of this more or less plastic coat may be the principal cause of this trouble. Experiments are under way to determine, if possible, more effective means of transmitting one-half of the load across the crack.

The following tests bear out the value of the above formula for use in designing concrete slabs to resist corner breaks. Example 1. On a corner formed by an open crack an 8,000 lb. load was applied repeatedly by means of a hydraulic jack. The slab was 6½ in. thick, 1:2:3½ mix, and about 1 year old. Fibre stress computed by the formula $S = \frac{3W}{d^2}$ is 569 lb. per square inch. The corner broke under the 76th application of the load. The subgrade had been removed from under the slab after the 30th application.

Example 2. On a similar corner a 6,000 lb. load was applied on a 6½-in. slab of the same mix and age. Computed fibre stress 426 lb. per square inch. The 62nd load broke the slab. The subgrade was a sand loam and had not been disturbed. The corner broke in the day time when the subgrade support should have been at a maximum.

Example 3. An 8,000 lb. load was applied in the same way to a corner formed by a construction joint. Short ⅝-in. dowel bars were in place across the otherwise open joint. Slab thickness 4¼ in., mix 1:2:3½, age about 6 months. Fibre stress computed by the formula $S = \frac{1.5W}{d}$ is 666 lb. per square inch. The corner broke at night under the 14th application of the load.

By means of the same outfit the behavior of several hundred other corners subjected to less than breaking loads have been observed. Using strain gauge readings as a measure of stresses we have been forced to the conclusion that under average conditions, material subgrade support to corners does not exist.

The Effect of Intensity of Traffic. From the above discussion, it is evident that aside from traffic accommodation considerations, roadways of a width such that under normal traffic conditions frequent turning off and on the slab by heavy trucks may be avoided, are much to be desired.

The fatigue experiments above referred to indicate clearly that the life of a concrete slab may be long or short depending upon the frequency of the passage of loads great enough to stress the concrete up to fifty per cent or more of its modulus of rupture. For example, our fatigue tests show that a few thousand repetitions of loads sufficient to stress the concrete up to 60 per cent of its modulus of rupture cause failure. If on a given road about 5,000 loads, sufficient to stress the concrete to this figure occur during the first month's use, the slab in all probability would fail the first month. If the same number of equal weight loads should not occur for several years it is entirely possible that the life of the pavement might be indefinite, as undoubtedly the modulus of rupture would have materially increased.

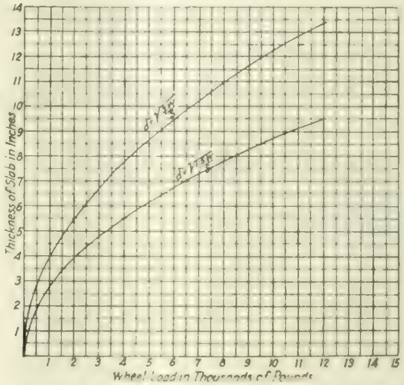


Fig. 7.—Required Slab Thickness—Allowable Fibre Stress 200 Lb. Per Square Inch.

In the light of the investigation showing the marked warping of concrete and monolithic brick pavements, due to temperature changes, it is the writer's judgment that such slabs should be designed for a corner strength sufficient to reduce the fibre stress to a safe limit regardless of the character of the subgrade. It is no doubt true that the higher the supporting power of the subgrade, the lower will be the fibre stress of the slab under day time applications of load, nevertheless the warping of the edges and corners upward at night is so great that the best of subgrades would be of little value in reducing the slab stress under night applications of maximum loads. Good subgrades may therefore materially prolong the life of a pavement by reducing the frequency of the occurrence of critical stresses. In such case, however, the occurrence of load breaks would be merely a matter of the intensity of traffic at night and during periods when the pavement is least supported by the subgrade unless the slab is designed for such critical conditions.

Material Inspection Methods of Illinois Division of Highways

By H. F. CLEMMER
Testing Engineer, Division of Highways, Illinois Department of Public Works and Buildings

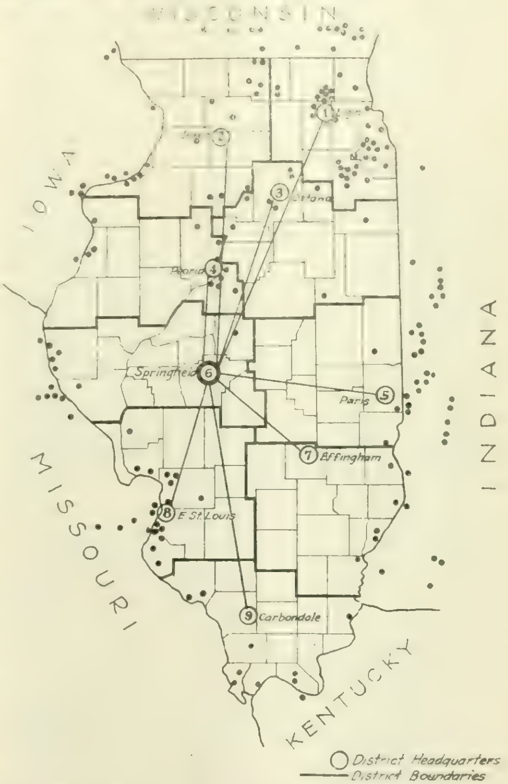
With the introduction of the immense highway building program in 1918 which called for hundreds of miles of paved roads involving the expenditure of millions of dollars, Illinois was faced with the problem of securing efficient inspection of road materials. So satisfactory has this problem been solved that no change from the present system is mentioned in the outline for construction for the following year, which calls for the building of far more miles of paved roads than have ever before been built in one year by any State in the United States or single province of a foreign nation.

Field inspection of highway materials in Illinois on a large scale began in 1919 when construction was started in this State on inter-state roads such as the Lincoln, Dixie, Chicago-Milwaukee, National Old Trails and Chicago-St. Louis Highways. Previous to this time the testing of road oils, asphalts, paints, creosoted wood blocks, bricks, steel and cement was accomplished by a small but efficient staff of engineers at the Highway Testing Laboratory in Springfield. The advent of construction such as the building of inter-state highways necessitated a system which would facilitate the testing of thousands of cubic yards of materials in the field. To meet this need, inspectors were placed over different sections of the highways under construction to travel back and forth inspecting the material as it arrived, and make reports each day to the Highway Testing Laboratory in Springfield. Cement was inspected at the seven mills supplying it by junior testing engineers who made their tests as soon as the material was loaded and immediately sent the reports of its acceptability to the resident engineers. During the year 1919, 299,329 yd. of sand, gravel and crushed stone and 751,489 bbl. of cement were inspected with exceptionally good results.

In 1920 a decided change in the method of inspecting aggregate was adopted. Inspectors instead of being placed at construction sites were located at the source of production. This system permitted the installation of inspection equipment of a more permanent nature, insuring in some degree better facilities for making a more thorough inspection. Perhaps the greatest advantage in adopting the "production site inspection" lies in the fact that rejection of unsuitable material at construction points is eliminated and consequently a saving in time and expense is experienced by the materials man, the contractor and the State. Though materials producers realize that specifications must be adhered to, the rejection of aggregates after they have been loaded and shipped to the construction site produces an irritation which does little to promote harmony in business relations. Illinois, however, was not led to make this change in system of inspection by any "good fellowship" feelings but rather by the benefits which she herself would derive. Though a slight increase in inspection cost was noted, savings along other lines more than eclipsed the added expense. A hastening of construction was apparent immediately. The materials men knew that when the car of material was shipped it would be used; the contractor knew his material passed specifications and preparations to use it immediately upon its arrival could be made without hesitancy; the State resident engineer could carry on his work without fear of hurry-up calls for inspectors and the resulting squabbles of rejections.

Under the new system, materials from 69 plants in Illinois and neighboring states were inspected. Over 690,000 cu. yd. of sand, gravel and crushed stone passed the tests made by the inspectors. During this year inspection was carried on at nine cement plants, 1,281,537 bbl. of the product being tested.

At the beginning of the present construction season an improvement was made on the already satisfactory system of inspection. District testing engineers—men with considerable experience in highway materials—were permanently located at district engineers' headquarters. The duties attached to this office are to supervise the work of the inspectors in the different districts and to co-operate in every respect with the district engineers in their efforts relating to materials. The testing engineers also visit construction sites, confer with the contractors and see that material troubles are cleared up in a quick and efficient manner. The value of organization was truly shown when, after adjustment to the new arrangement, a remarkably smooth running inspection "machine" has resulted, which, strange as it may seem, has proven satisfactory to every one connected with the construction of Illinois highways. Inspectors are able to settle small difficulties in little time. Long and repeated correspondence has given way to the short telegram or card to the district testing engineer. The written letter was replaced by the face to face interview which brings far better results and leaves behind a much better feeling. District engineers are able to take up their materials troubles with one person instead of twenty. The testing engineer at Springfield is not called upon to settle minor troubles at a hundred places, but in conference with nine men he controls the inspection activities at all plants furnishing materials.



Map Showing Location of District Testing Engineers.

During the first eight months of this year over 650,000 cu. yd. of aggregates were inspected for use in Illinois highways. This material came from 80 different plants in Illinois and surrounding states. Cement aggregating over 910,000 bbl. was also tested during this period of time by junior testing engineers located at 12 different mills.

It would appear that inspection as thorough and on such a large scale as carried on by Illinois could not be economically maintained. A careful accounting of the costs of inspection during 1920 was made and, including the laboratory expense, was found to be a trifle less than .7 of 1 per cent of the construction costs. This year a slight increase is expected, but it is thought that the most liberal estimate will still keep the costs under 1 per cent of the construction expense. With inspection as efficient as maintained at present, such an expense is easily justifiable.

The advantages of inspecting material at the source of its production were so pronounced that it was decided to attempt this method in inspecting steel. An inspector was stationed in Chicago early in the spring of the year and the results of his work were gratifying to such an extent that the department has maintained this system of inspection throughout the year, and intends to continue it in the future. Mill operators as well as contractors are particularly pleased with the present system, and difficulties have apparently ceased in the inspection of this type of construction materials.

The success of Illinois inspection system is based, in a great measure, upon the type of inspector and the training he has had and gets before he is sent to the field. Technically trained men make up the greater part of the field force, but whether these men are engineers or not they must have one qualification which has proven to be essential to the success of an inspector—personality. At its best, inspection work is of a nerve-trying nature with the materials men at the disadvantageous position. To be able to reject material and still "get along" with the men in charge is a characteristic which an inspector in the Bureau of Tests of Illinois must possess.

In spite of what engineering development a man may have had, when he comes to this department he must go through a regular course of training before he is placed on a job. This training occupies a week and is carried out in the laboratory at Springfield. A thorough course of inspection involving difficulties which may come up in the field, laboratory and construction site, is given each prospective inspector. A knowledge of the system of records is also required, as well as the making up of daily reports. After the course of training has been completed, a rigid examination, which includes the various phases of inspection work, is given the candidate. A passing grade must be obtained before any person is retained as an inspector. When a new inspector goes into the field, the district testing engineer stays with him until he is quite familiar with the work.

In testing aggregates at the plants, samples of the material are taken from each car to be shipped. These samples are given a mechanical analysis, a silt analysis and a visual inspection. The mechanical analysis, made with standard screens, determines the gradation of the aggregates. The visual inspection is made for the purpose of "spotting" shale, shells and other soft material. Each inspector is required to send in to the main office a daily report on material inspected and shipped. The report contains the results of the tests made, the quantity of the material shipped, the source of its production and the contractor to whom the material is consigned. These reports are made up in triplicate form; one to go to the main office, one to the district engineer and the third to the resident engineer of the section to which the material is consigned. Upon receipt of the report the resident engineer fills out that portion of the report which pertains to the section number, the county and the route where the material is to be used.

Working in conjunction with the field force of inspectors is the testing department of the laboratory at Springfield. Previous to the placing of the proper equipment at production points and the locating of inspectors at these places, the laboratory was called upon to test all material of which there was the slightest doubt. Under the new system only special cases of testing are handled in the laboratory. At the opening of any new sand or gravel pit, stone quarry, or cement mill which is to furnish material for Illinois highways, samples of the product are thoroughly tested in the laboratory. Also at the beginning and at the end of each construction season, samples from all plants which supplied material during the year are given "quality tests." These tests, in the case of sand and gravel, include sieve analysis, washing, wearing qualities, organic material content, and other standard tests. Rock is tested for wear, specific gravity, absorption, hardness, toughness and cementation value. Cement is given a chemical test besides tests for soundness, time of set, fineness and tensile strength. All tests are kept in a permanent record book, and serve as checks on the quality of material produced.

Fabricating Shop Contracts. The records of the Bridge Builders' & Structural Society, from reports collected by its secretary, show that during the month of January, 1922, [illegible] tons of fabricated structural steel was contracted for throughout the United States, equivalent to [illegible] per cent of the entire capacity of the bridge and structural shops of the country.

Recent Developments in Road Construction Details

New Features in Highway Building Outlined in Paper Presented at Omaha Convention of American Association of State Highway Officials

By CHARLES M. UPHAM

Chief Engineer, North Carolina State Highway Commission

Half-Width Roads. The construction of half-width roads can hardly be called recent. It has been found that this method may be followed and satisfactory results obtained. This development of road construction releases the traffic from the long rough detours, which are very often present in road construction, and makes the road available for traffic during construction.

This method has been utilized satisfactorily in the case of the construction of the bituminous type pavements, and, in a few instances, it has brought about good results in the construction of water-bound macadam, but it is generally used in concrete road construction.

Where this road is constructed for a heavy duty road, it is very often heavily reinforced, and each half of the road is kept separate and apart from the other half, so that the complete pavement really consists of two strips of pavement laid side by side. In this method of construction the heavy reinforcement is longitudinal, and, on account of the center line joint taking up the vertical movement of the pavement, thus eliminating any longitudinal cracking, and the transverse cracking is decreased to a minimum, even in the part of the country that is subjected to heavy frost.

In other instances tie rods have been used to tie the two strips of pavement together. This method, however, introduces difficult details in construction, and at the present time has shown no particular advantage over the other. The practical advantage of the longitudinal joint is in the fact that the construction joint is easily maintained, and is not especially objectionable in appearance, while a jagged, irregular longitudinal crack is difficult to maintain, and is very unsightly in appearance.

In some states this longitudinal or center line construction joint is provided, even though the pavement is constructed in one operation, the advantage being the same as when the pavement is constructed in two sections.

Widening Old Macadam.—Another recent development is the widening out and the reclaiming of old macadam roads by building a strip of hard surface pavement on each side of the macadam. On either side of the old macadam road varying from 5 to 10 ft. in width, there is placed a strip of concrete pavement from 9 to 10 ft. wide; these strips being sometimes reinforced. This method furnishes a comparatively wide pavement, and renders useful a road which would otherwise be too narrow to be of any service to traffic.

Increasing Amount of Reinforcement in Concrete Roads. Another development in road surfacing has been the general tendency to increase the amount of reinforcement in concrete roads.

Only a short time ago many engineers were reinforcing their roads with metal wiring, approximately 25 to 27 lb. to 100 sq. ft. At the present time it is a common practice to use approximately three times this amount, with the tendency to still further increase the weight of material. The Specifications of North Carolina for 1922 will undoubtedly call for metal amounting to nearly 100 lb. for each 100 sq. ft.

This has effected a large economical advantage in the cost of roads, which has brought a reinforced concrete surface to the point where the changes in reinforcements are not left to the imagination. The present price of steel has made it possible to create considerable saving in dollars by the construction of thinner concrete pavements. Where reinforcement has been used in most cases the road has been constructed of a universal thickness, this also affording a considerable saving of concrete.

Batch Transfer and Central Mixing. Much progress has been made in the methods of laying concrete pavements, the tendency being not to allow concrete materials to be placed on the subgrade. The batch transfer method is now becoming a standard form of construction. This method has proven economical, in most instances, and capable of large yardage.

There have been many combinations of this method, such as hauling by industrial railway with the batch boxes carried upon the railway cars; as well as the motor truck hauling with the batch boxes loaded on the trucks; and the trucks being provided with batch compartments. In some instances the batches have been hauled a portion of the distance by trucks and transferred to industrial railway. This has proven a very economical combination in many cases.

The central mixing plant for concrete pavements is now commending itself on many projects. In most cases the ready-mixed concrete is hauled to the construction by means of trucks. The only detail in this method which can be considered questionable at this time, is the transferring of the concrete from the trucks. It is possible in many cases that there is a segregation of aggregates and, no doubt, this detail must be overcome, but this method of construction is bound to gain in popularity from year to year.

In a few instances engineers are calling for a piece of bituminous surface road to be constructed on 1:2:4 concrete and requiring that the concrete base be properly cured, as called for in concrete surface, for a period of at least two weeks.

Covering Green Concrete Pavements.—For a long time the curing of concrete pavements has been neglected, and it is only recently that this detail of construction has been given the proper attention. One of the most important developments which has been brought about recently is the use of the burlap covering in the early curing of concrete surface.

The finished pavement is covered with strips of burlap, approximately 4 ft. in width, and extending the entire width of the pavement. This burlap is kept wet and then placed on the finished concrete surface from about 10 to 20 ft. back of the finishing operation. The slight marking of the surface from the burlap is negligible.

The burlap should never be allowed to dry out and thus the concrete does not lack the necessary water for hydrating in the early periods, a condition which has often existed in the other methods of curing concrete roads.

I consider that this is one of the greatest developments of details, and one which has actually improved the lasting quality of concrete. As soon as the road surface becomes hardened the burlap is rolled up and ready for the next day's work, while the concrete road surface is covered with earth, sprinkled and wet in the usual manner.

Riding Qualities of New Road.—Many specifications are now including regulations as to the riding qualities and evenness of the concrete road surface. Ordinarily this cannot be tested until the next day when the concrete has hardened sufficiently to bear one's weight. Recently there has been an appliance invented which consists of an extremely light straight edge, which may be fastened to the end of two handles in order to reach out to the road surface and test the surface before it has become hardened.

Curing Concrete Pavements.—Many other experiments have been carried out in the detail of curing concrete pavements, but no definite results have been obtained. One state has used calcium chloride in solution applied on approximately 1 in. of earth covering. Another method tried has been the covering of the concrete surface with a heavy asphaltic oil. The oil was applied to the road in the proportion of about 6/10 gal. per sq. yd., and in two weeks' curing period the asphalt was peeled off and again used. No definite recommendation is made at the present time in regard to this method.

Another extraordinary experiment has consisted of the oiling of the subgrade preparatory to the laying of the concrete pavement, the object being to prevent mud during the light showers. It has been found that when the light truck is used this oiling proves to be a considerable advantage, and, no doubt, the oil offers some assistance to the stabilization of the subgrade.

Steel Bar Reinforcement.—While for a long time it has been customary to use wire fabric in the reinforcement of concrete highways, steel bars are occasionally used, and while there has been no development in regard to the use of this fabric reinforcement, there is, however, a change in the method of using steel bars. The new development consists of making these bars into a mat, consisting approximately of 10 to 14 bars transversely, and about 5 bars longitudinally. The mat is then wired together and handled as sheet reinforcement.

The use of dowels at the transverse construction joint can hardly be considered as new, as this method has been carried on for several years, and found to be very satisfactory in overcoming the tendency of one slab to rise above the other.

Another method in construction detail is the installation of fibre conduits placed transversely across the road at various intervals, especially through small towns and villages. It is the function of these conduits to provide a means for gas water and electric wiring to cross the road without making it necessary to break up the pavement.

Bituminous and Brick Developments.—In the construction of sheet asphalt surfaces there is a tendency to be more liberal in the grading of sand aggregates, and the use of a lower penetration asphalt. There is also an inclination to use a 3-wheel roller in compacting the sheet asphalt surface. While this is not absolutely new, its use has never been universal.

Another new development is in the combining of a binder course and sheet asphalt surface in the one course, which virtually consists of a stone-filled sheet asphalt; the stone composing from 25 to 60 per cent of the entire surface. When this surface is used no binder course is laid, and the surface is compacted as an ordinary asphaltic concrete.

Recent developments in brick pavements have shown that the vertical fibre brick laid on a concrete base and sand cushion, grouted with a bituminous material is capable of withstanding the ravages of traffic.

"Progressive Type" of Road in North Carolina.—The findings of the Subgrade Committee, of which Senator du Pont is chairman, have shown that the traffic-bearing properties of the pavement depend greatly upon the stability of the subgrades, and that the subgrade can be greatly stabilized by being mixed or covered with a non-capillary material, such as sand, gravel or top soil. This has led to the development of what, in North Carolina, has been termed the "Progressive Type" road, which consists, first, of the grading of the road and the building of drainage structures, and then surfacing with a non-capillary material, such as gravel, sand, clay or top soil, which, in truth, is nothing more than the construction of a subgrade highway for a future constructed hard surface pavement. This can be maintained as a subgrade highway for medium traffic at a reasonable cost, and, when occasion demands, it can serve as a high bearing value subgrade for any type of surface desired. This method of construction means that all previous steps in the construction have been preserved and that the completion of a hard surface road is merely an addition; there being no economic loss whatever, due to the fact that the previous work is incorporated into the completed hard surface road.

Waterproofing Sand-Clay on Top Soil Roads.—I would not consider this paper complete without describing one of the new methods we are trying, and which promises to be very satisfactory in the treatment of constructed subgrade highways, now being utilized as roads, and in the treatment of top soil or sand-clay roads. Many states are situated similarly to North Carolina to the extent of having a large mileage of sand-clay top soil, or gravel surfaces.

There has been much experimenting in the attempt to secure a bituminous material which would satisfactorily preserve this type of road surface. It was generally found that any bituminous material sufficiently light to penetrate this surface would have practically no binding qualities, and that any bituminous material sufficiently heavy to have binding qualities would form a mat on the top of the road surface, and soon peel off, due to the dusting of the road surface directly underneath the bituminous covering. The weak point in this treatment was not in the bituminous blanket, but in the contact of the bituminous blanket with the road surface.

North Carolina is attempting to develop a method which will correct this weakness, and provide a contact between the bituminous covering and the road surface. The method consists of softening the road surface by means of sprinkling and then rolling into this surface broken stone or gravel of approximately 1½ in. in size. After this has become thoroughly imbedded in the top soil or sand-clay it is allowed to dry out, and subjected to traffic for a short period, after which it is swept clean by brooming.

The road surface now consists of a [illegible] layer of crushed stone imbedded in the strong and rigid sand-clay or top soil surface and forms a satisfactory bond of contact for the bituminous material. Thus a sufficiently heavy material to have bonding qualities can be applied to the sand-clay road and the layer of broken stone will prevent the cutting up of the road surface directly underneath the bituminous [illegible]. By scarifying the top soil or sand-clay in this manner a strong pavement is presented and after the first application of the bituminous material a road can be built by [illegible] surface types of pavement. While this method has not been in practice long enough to prove its complete success, the developments shown show that for a small expenditure a [illegible] top soil road can be materially improved.

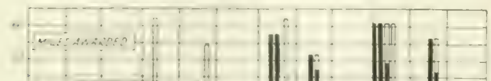
1921 Road Construction in Illinois

By B. H. PIEPMEIER,

Engineer of Construction, Department of Public Works and Buildings, Division of Highways.

The illustration shows the total amount of road work placed under contract and built in Illinois during 1921. The chart shows graphically, by weeks, the progress made in construction. It will be noted that the first pavement was laid in April. Under normal seasonal conditions April is the first month in which pavement can be laid in Illinois. The chart indicates that it is possible to get in approximately eight months of work in this latitude. Considering the delays due to weather conditions and other causes, the maximum time that any one mixer can be operated is approximately 129 days.

Out of the 162 independent pavers used in the state during 1921 one 21-E paver was operated 129 days; two were operated 121 days; two 105 days; and the remainder less than 100 days. Fifty per cent was of the 4-bag or 21-E type. The average for all mixers of this type, considering all jobs and all days on which the mixer was operated, was 371 ft. per day.



Comparison Between Miles of Highway Awarded and Miles Constructed in 1921.

A few special records were made. In one instance a 28-E paver (9-bag) in 10½ hours, laid 1,434 ft. of 16-ft. pavement, or 2,549 sq. yd. In another instance, two different contractors on night and day shift with a 21-E paver (5-bag) laid approximately 2,500 sq. yd. The two contractors making this average also made several weeks' run of 1 mile per week, working double shifts.

During 1922 the specifications will not permit materials to be dumped on the subgrade.

Business Is Better and Will Continue to Improve

The following is an abstract of an article by Bruce Barton in the American Magazine for March. The article is based on an interview with Henry S. Dennison, president of a manufacturing firm that deals with 50,000 business houses in America and abroad. Mr. Dennison has twice been president of the Taylor Society, and is one of the few business men who foresaw the business depression that began two years ago. He tells how he was able to forecast it, and why he now believes that business is on the upswing of the cycle. Mr. Dennison said:

"We manufacture shipping tags which are used by producers, jobbers, retailers and private individuals in every town and for every conceivable purpose. Our sales records, therefore, are a pretty good reflection of general business activity; they show immediately whether people are buying goods and shipping them by freight and express. Along come the first faint thunders of a crisis, the more cautious folk stop placing orders, and our sales show a decrease in comparison with the same period of the preceding year. Week by week the decline in our sales continues, but we are not panic-stricken, we know there is a bottom to the curve, and we know just about when it is going to be reached. If the preceding prosperity wave was a full one, the bottom of the downward curve will be reached in about one year. Then a gradual improvement will set in, but not until thirteen months or more have passed will we begin to show healthy increases again. All this is made clearer if you will look at the accompanying table.

How Long It Takes to Get Over a Panic.

The Seven Panics Before the One of 1920-1921.

Date of each period of depression	Time taken to reach the lowest point	Time from the lowest point to normal business again
1874-'76	[illegible] mos.	13-21 mos.
1884-'85	[illegible] mos.	13 mos.
1893-'94	[illegible] mos.	15 mos.
1895-'97	7-10 mos.	16 mos.
1907-'08	[illegible] mos.	15 mos.
1911	[illegible] mos.	5-7 mos.
1914-'15	[illegible] mos.	13 mos.

These figures are from the records of the Dennison Manufacturing Company. Those in the center column show the number of months that elapsed in each crisis between the time when the sales of the company began to show decreases and the time when the percentage of decrease was the greatest. The right hand column shows the number of months that elapsed between the time when sales began to recover and the time when they began again to gain on the basis of the latest preceding normal year.

In the present depression the sales of the company began to fall off in November, 1920, and began to show signs of recovery about the latter part of the summer of 1921. We are now on the upward curve of the cycle on our way to normal business. These cycles are of two kinds, major and minor. Mr. Dennison explains clearly how to anticipate these cycles, and how to predict their length.

"Panics come disguised under different sets of circumstances; they assume different names—there was the 'railroad panic' of 1884, and the 'Baring panic' of 1890, and the 'Roosevelt panic' of 1907. They put on false whiskers and false names; but when you have stripped them of all disguise they stand revealed as first cousins. No one of them has anything fundamentally new or different to present; most of them run the same course within a very limited range of variation—about one year from top to bottom and another year to the next wave of prosperity.

"So we get back to the question which you asked at the beginning. Why it was that away up here in Framingham we should have been able to call the turn on the situation as early as January, 1920? The answer is that, being thoroughly persuaded of the soundness of the cycle theory, we avail ourselves of every bit of information that can possibly enter into a business forecast. Among other things, we have evolved this general rule, which is worth remembering:

"When you are in a period of moderate prosperity you can look for some sort of a change in from 18 to 24 months;

when you are in the midst of a riot of prosperity, such as marked the closing months of 1919, you can look for a change to begin in about 12 months.

"It was on the basis of this simple rule of thumb that we began, watchfully, in January, 1920, to get ready for a break in prices; and when it came in November it found us prepared."

At this point I asked Mr. Dennison a few questions.

"Your business has passed through ten crises," I remarked. "How many more will it probably pass through in the next twenty-five years? Or, put it another way. Suppose a man is somewhere between 25 and 35 today. He has a normal expectancy of 35 or 40 years. How many crises will he encounter? How can he sense their coming and turn them to advantage, instead of being bowled over by them?'"

"It's too bad we cannot answer those questions in exact detail," Mr. Dennison answered with a smile. "If we could, we should have an almost infallible formula for acquiring wealth. But it is worth while to keep in mind this general theory that there are two cycles, one corresponding with the waves of the sea and the other with the broader tidal movements. Thus we have the minor cycles, which have an average length of about three years, and the major cycles, which seem to consist of from seven to ten years of generally good times and seven to ten years of less prosperous times.

"Thus the years between 1890 and 1896 were hard years, and hence the minor cycles brought severe depression in 1893 and 1896. The years between 1897 and 1907, on the other hand, were good years; and therefore the minor depressions of 1900 and 1903 were barely noticed by most of the businesses of the world. Again, from 1907 to 1915 times were poor. The crisis at the end of 1907 (which, by the way, was definitely forecast by students of the cycle theory) was sharp and severe; and the rise of the next cycle was so small that there was little distance to fall in 1911; but 1914 brought another severe depression, which was cut short by the war boom.

"So your young man with 35 or 40 years of active life before him will probably see the complete round of two major cycles, including four or five short cycles bringing intense business activity, and four or five bringing severe depressions. In other words, the definite opportunity to make or to save money will be offered to him eight or ten different times before he becomes too old to work. If he keeps his head when prices are rising, and reminds himself that prosperity does not last permanently, he will save a surplus and have it ready to invest when the curve dips down and securities pass from the hands of the shortsighted into the hands of those who study the facts. If, on the other hand, he merely 'takes things as they come,' he is likely to spend his life in being alternately lifted and dipped by the waves, but without being carried any nearer the shore of ultimate independence.

"There are three very definite rules that your young man ought to lay down for himself it seems to me:

"First of all, he should begin right now to make himself thoroughly familiar with trends of business, as reflected in business statistics and the day's news. It is not enough for him to know the facts and figures of his own concern; special conditions may throw one or more kinds of business out of line for a certain period and make their figures valueless. Nor it is enough merely to study the general theory of cycles; for the theory is still far from fully developed, and those who know most about it are most careful to surround their predictions with 'ifs' and 'buts.' No, your young man must form the rare habit of studying the facts from day to day, and forming his own conclusions.

"He will, of course, study the weekly statement of the Federal Reserve Bank, and will remind himself that when the bank statement shows its biggest figures, it means that everybody is borrowing, prices are booming, and the strain on the nation's credit is growing greater every week. When, on the other hand, the banks are full of money, it is because business transactions are reduced to a minimum. That is the time to look for cheaper money and a beginning of the upswing.

"He will watch the reports of labor conditions and the bulletins of strikes in various parts of the country. When strikes are at their maximum he will know that the up-swing is almost over; for strikes come most frequently when prices have been rising for some time and labor's needs and demands are most pressing.

"He will follow carefully the increase or decrease in building permits. New building stops when a panic hits us, and building permits usually begin to increase while business is still dragging bottom—an indication that the farsighted are taking advantage of the low prices and getting ready for better times.

"Finally, he will be very much interested in the number of business failures reported by commercial agencies each week. Every business failure spreads pessimism, and when the weekly report of failures is at a maximum the pessimism of the crowd is deepest. The wise man knows that this is the time to take hope. The weak, over-expanded concerns have been eliminated, inventories have been liquidated, bank loans paid up, and the country is getting ready for another period of sound progress. On the contrary, when business failures fall to the vanishing point and optimism reigns supreme, the wise man will begin to get out his umbrella. When nobody fails it means that prices are going up so fast that even the most foolish are making money. That is the time to be afraid.

"Little by little, of course, as more and more men understand this alternation of action and reaction, the swings of the pendulum will grow a little less violent. Ultimately, we ought to be able to trim the curve at the top and bottom considerably, and get rid of a great mass of needless suffering in consequence. If, when prices are leaping, every business man would restrict his purchases a little, if every sales manager, instead of encouraging his customers to bid against each other, would be content with smaller but more sensible orders, then we should come into the bad times with smaller inventories, factories could keep running more nearly on full time, there would be less unemployment, hence less reduction of the purchasing power and a far more rapid recovery.

"The governments—national and state and local—can, and should, render very great aid. What happens now is this: When the prices of materials are at the top, when labor is scarce and dear, the Government enters the market and bids the prices up. It elects, at that worst time, to build our roads and drain our swamps, and put up our new court houses and post offices. Suppose the Government kept out of the market all it could at that time; suppose it put part of its tax money into the banks and waited for the dull period. Suppose, when times are at their worst, it should step forward with several millions or billions of dollars for new construction work, creating a demand for steel and stone, and an opportunity for thousands of men who would otherwise be unemployed. What a difference that would make!"

Engineering for Primary Roads in Iowa Cost 5.91 Per Cent.—Primary road engineering for Iowa highways during the past five years has been done at an average of 5.91 per cent of the total cost of the improvement, according to the January Service Bulletin of the Iowa State Highway Commission. Surveys and plans for 2,225.35 miles of road, since the first law accepting federal aid was passed in April, 1917, cost $472,858. This is an average cost of $212.48 per mile for this important part of the work. The estimated cost of construction of the 2,225.35 miles was $26,855,185, making the percentage 1.77 for the surveys and plans. Construction work has been carried out on a total of $21,148,242 worth of this work at a total cost for supervision, inspection on construction and inspection and tests of material of $874,403, making the percentage 4.14. Thus the total cost of all engineering work chargeable to the primary road projects, the making of surveys, preparation of specifications and plans, keeping of records and all general supervision work, including tests of materials, is 5.91 per cent of the cost of the work.

Government Needs Explosives Chemists.—The U. S. Civil Service Commission announces that there are a number of vacancies in the Ordnance Department of the Army in positions of chemist qualified in the chemistry of explosives. These positions offer salaries ranging from $1,800 to $3,600 a year, depending upon the qualifications of the appointee and the duties to which assignment is made. Applicants are not assembled for written tests, but are rated upon the subjects of (1) education, training and experience, weighted at 70 per cent, and (2) publications or thesis, to be filed with applications, weighted at 30 per cent.

Importance of Surface Finish of Concrete Roads*

By [illegible]

[illegible]

[illegible]

We know now that impact is the great cause of destruction [of] concrete pavements. Impact is the bumping or banging of one object upon another. As I roll a smooth cylinder along a smooth table there is practically no impact but let [illegible] in the table and as the cylinder bumps along over them we get a series of impacts that, if the cylinder be heavy enough and rolled often enough, will soon wear out the surface and damage the structure.

That is analogous to what is happening to our roads. If the wheels of vehicles are smooth and the pavement surface is smooth there is no damaging impact from traffic. The road lives even though it be built in proportion to the volume and weight of traffic it must carry. But let surface irregularities develop, and no matter how strongly built, the whole pavement soon shows the effect of wear.

We build our roads on an average to withstand a pressure of 800 lb. per lineal inch width of tire. Yet if an unevenness in surface of only ¼ in. occurs, the impact of the one rear wheel of a 5-ton truck may exert an impact pressure upon the road of 20000 lb. Under such pressure the unevenness becomes a depreciation whose edges spall and break, causing further impacts and more depressions until the pavement is badly damaged.

In order to lessen impact we must get and keep smooth surfaces. How can we do it? Close scrutiny of work and infinite attention to detail are essential. Then there are certain general remedies suggested by the general cases of unevenness, specific remedies being tried by different states or on different jobs, and different methods of work and machinery.

Cause of Unevenness in Pavement Surfaces. There are five general causes of unevenness in the pavement surface:

1. Foreign materials in the aggregate, which, failing to amalgamate are ousted, leaving holes and depressions.
2. Non-uniform aggregates which cause inequalities in wearing resistance to traffic and subsequent depressions at the weaker place.
3. Poor workmanship in striking off and finishing.
4. Cracks, longitudinal and transverse, due to frost action, changes of temperature or unequal bearing power in the subsoil.
5. Uneven joints, perhaps the most common cause of surface trouble, due often to the riding up of joint material or to difference in elevation of slab surface.

The general remedies for surface unevenness are as obvious as the unevenness itself and therefore, perhaps, as often neglected: strict specifications exacting good material and good workmanship. More and more we are getting them on paper. The problem is their application to the job. [illegible] Here [illegible] co-operation between engineer and contractor. [illegible] The answer is at once made that the relationship should be one of co-operation and mutual endeavor toward a common end: the best possible road.

[illegible] a financial gamble, then we shall have that adherence to specifications that will insure good work and smooth surfaces.

Methods of Preserving Surface Finish.—Three other general methods of preserving good surface finish once it is obtained are the use of steel reinforcement, the division of the road longitudinally, and the wider spacing of joints with the use of dowels.

The advantages of steel reinforcement are that it gives the road greater bearing power and greater resistance to frost action and that it offsets irregularities and weaknesses in the subsoil. By helping to preserve the integrity of the pavement, it minimizes any tendency towards cracking, which is of course a cause of surface unevenness.

The division of the road longitudinally increases its beam strength about fourfold. Observation reveals that longitudinal cracks are not found in slabs 9 and 10 ft. wide, though we have all encountered them in slabs beyond that width. The reason for this difference is still conjectural, but until it is ascertained we would do well to be guided by results hitherto obtained, and build our concrete roads in two longitudinal sections.

Transverse joints being a prolific source of trouble, it is well to diminish their number as far as possible through the use of the longer slab. The wider spacing of joints becomes feasible through the use of steel reinforcement to meet the temperature stresses of the slab. The use of dowels gives stability to the joints and holds the surface even. The submergence of the joints an inch below the surface has proven unsatisfactory. Devised at first to secure a smooth surface and permit the use of a finishing machine, it seemed admirable until subsequent expansion crowded and crushed the concrete above the joint material, leaving a badly ravelled and spalled joint. The best method that I have found of making a joint is to submerge the joint material until after the screed or finishing machine has passed over it; then to lift the joint material slightly above the surface with long fingered tongs; then to finish the joint with the split float or split roller, rounding the concrete next to the joint material with an edging tool.

Specific application of these general principles is found in the requirements of such states as Delaware, Pennsylvania and New York. In these states, and others, the specifications exact good workmanship by allowing a maximum of only ¼ in. depression in 10 ft. of pavement tested with a straight edge. The use of the straight edge on green concrete indicates depressions to be rectified and insures good results. These states specify materials with such precision as almost certainly to preclude the use of foreign materials in the aggregate or of non-uniform aggregates. They design the roads so as to minimize the danger of movement in the slab and resulting cracks. And they give special attention to the placing of joints and to the suitability of the machinery in use.

All of these precautions were taken on the road built last summer in Bennington, Vt., by the Fred T. Ley Co., and so far not the slightest indication of any surface unevenness has appeared on it. This tends to support my belief that we are going to be able to build roads within necessary financial limits that under the traffic permitted by law will be practically indestructible.

Methods of Surface Finishing.—The actual method of finishing is of course important in securing a smooth surface. Some road builders prefer to use the finishing machine with the roller and belt. It is essential that the roller be light. A too heavy roller pulls the crown out of the pavement, and spoils the surface. Most specifications call for a weight of from 12 to 15 lb. per foot length. Some builders omit the roller, using only the machine. My own experience indicates that the roller be used. One advantage of the finishing machine is that a dryer concrete can be used with it, which gives greater strength to the pavement. It also gives more uniform results than can be obtained with a green gang, and seems in general more fool-proof than the hand method. Still many prefer to strike off with the hand screed, using the roller and belt. This has the advantage of making one piece of plant the less to get out of order and where a heavy screed is used in the hands of competent workmen it gives as smooth a finish as the finishing machine.

With either method the board belt gives unquestionably the best finish. The hose belt however can give good results. Proper belting takes off not only the water, but also the clay, loam, laitance, etc., that tend to form scale on the surface.

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*[illegible]

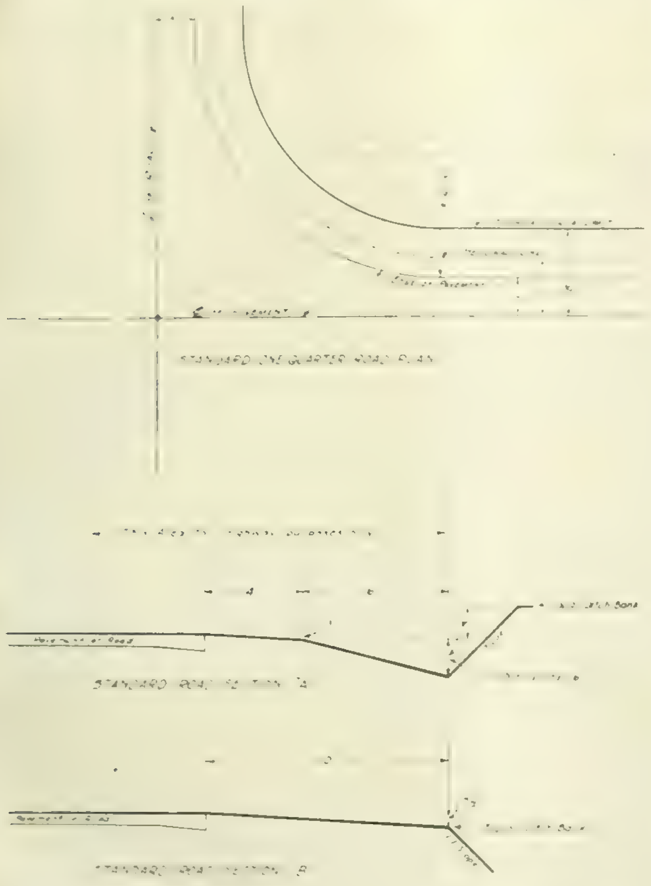
Providing for Irrigation Ditches in Highway Right of Way

By D. A. McCLUNG,

[illegible]

When Maricopa County, Arizona started the biggest county road paving program in the world a condition was found that probably does not exist in many communities. While a right of way of 66 ft. in width existed along the section lines, upon which the roads were located, difficulty was encountered in finding sufficient space for the pavement with its shoulders and drainage gutters.

The broad flat floor of the Salt River Valley, in which the paving project is located, is traversed by a network of irrigation laterals and drainage ditches. These channels are invariably located in the road right of way, scarcely a mile of road being without one or more irrigation laterals or ditches, which, owing to their necessary elevation above the land, are built with high banks and occupy an over-all width of from 10 to 18 ft. Drainage ditches are either in existence or are proposed along the entire road mileage and are usually on the opposite side of the road from the irrigation channels. Perceiving that when the drainage system has been completed, the roadway would be definitely limited by the parallel channels, it was considered advisable to adopt some standard rules governing the construction of waterways in the future and the following regulations were prepared:



Standard Road Plan and Standard Sections, Maricopa County Highway Commission.

MARICOPA COUNTY HIGHWAY COMMISSION

General Regulations

for the performance of any work or the building of any structures within the right of way of any paving project of the Maricopa County Highway Commission by any parties other than county officials or employes performing such work for Maricopa County.

(1) No work shall be performed or structures built within the right of way of Maricopa County Highway Commission's paving projects without a written permit for same.

(2) No ditches, structures, embankments, pits, waste earth or other materials may be built, placed or removed within the limits designated "Area for Highway Purposes Only" on the accompanying drawing, except as provided in the following paragraphs of these regulations. The accompanying [illegible] drawing [illegible] applies to all intersecting roads [illegible] whether or not intersecting road is in the paving project [illegible] all intersecting [illegible] whether or not roads have been opened [illegible].

(3) After pavement is placed and cleaned off, waste earth may be deposited within the limits defined [illegible] provided the resulting finished surface is left [illegible] above the elevation shown on the Maricopa County Highway Commission's Standard Road Sections A and B on the accompanying drawing [illegible] of adjacent ditch or structure [illegible].

No material may be taken from the area [illegible] which will leave the resulting finished surface below the elevation shown on the Standard Road Section.

(4) Culverts. All culverts within the [illegible] limits shall conform to the Maricopa County Highway Commission's plans and specifications for these structures and may be [illegible]. A head wall shall be located between the [illegible] designated "head wall line" on the accompanying standard plan above referred to. All pipes entering 18 in. or less outside the "head wall line" shall have standard concrete head walls unless said pipe enters some existing irrigation or drainage structure other than an open earth ditch or channel. Where culverts are built to extend across or into the space between the "head wall line" and the "highway area limits," proper provision shall be made for the necessary surface drainage parallel to the pavement or road at the lowest point in the "standard section."

(5) These regulations are minimum requirements and may be amended by the Maricopa County Highway Commission in cases where other specifications are considered necessary.

Under these regulations it is possible in the majority of cases to construct drainage channels on the road right of way, if care is taken to locate them on the outer edge of same. However, in some instances the licensee has found it necessary to secure extra right of way on adjoining land.

Of the two standard road sections, Section "A" shows the typical irrigation ditch bank, while Section "B" indicates the typical drainage channel. On account of danger from leakage or overflow of the irrigation channel, a gutter is provided between the channel and pavement. As stated in paragraph 5 of the regulations, these are minimum requirements and those interested are expected to build new structures and channels as far from the pavement as practicable.

Maintenance Cost of Iowa Highways

The total expenditure from maintenance funds from Jan. 1, 1921, to Jan. 1, 1922, for maintenance of 6,616 miles of primary roads of Iowa was $2,192,786, or an average of $332 per mile. This total expenditure was divided as follows:

	Total	Average per mile
Patrol maintenance	$1,153,605	$174
Gang maintenance	612,521	93
Equipment and tools (new equipment and rentals)	329,197	50
Addition and betterments	89,420	14
Bridge maintenance*	8,044	1
Total	2,192,787	332

---

*This represents only a small part of the total money spent for bridge maintenance. A large part of the bridge maintenance was paid from county fund.

The first three items above, patrol maintenance, gang maintenance and equipment and tools constitute the actual amount of money spent for road maintenance. This total is $2,095,323, an average of $317 per mile.

The expenditure for actual maintenance was divided between the various classes of road as follows:

[illegible] miles earth road at $[illegible] per mile	$1,[illegible]
1,[illegible] miles of gravel at $452 per mile	521,[illegible]
[illegible] miles of paving at $[illegible] per mile	21,[illegible]
Total [illegible] at $317 per mile	2,[illegible]

In comparing these maintenance costs on the different types, two factors should not be lost sight of. First, the types listed do not carry equal traffic, and second, they do not give equal serviceability. It is probable that the average daily traffic on the paved roads is twice as great as on the gravel and the traffic on the gravel in turn, about twice that on the earth. The paving gives 100 per cent service every day in the year; the gravel gives service throughout the year but it is not always 100 per cent; the earth road serviceability ranges from near zero after prolonged rains to 100 per cent when the roads have dried out and have been properly maintained.

We are indebted to W. H. Root, Maintenance Engineer of the Iowa State Highway Commission, for the above information.

Bituminous Gravel and Sand Roads

Experiences in Massachusetts Described in Paper Presented at Annual Convention of Canadian Good Roads Association, Halifax, N. S.

By W. D. SOHIER,

[illegible] Massachusetts Highway [illegible]

[illegible] bituminous treatments, surface treatments as well as bituminous construction will be discussed. To [illegible] of all the road surface to be treated or covered must be absolutely well compacted, firm, and true to crown and grade with no dust pockets or soft material. The [illegible] should be brushed clean and the gravel road well shaped and free from surplus loose dust.

A bituminous top on a road is waterproof and it must not be put on any road that is rough or rutted, because if it is, it will hold water in the depression, and every passing automobile or team will force the water out and take pieces of the road with it so that in a short time you have very large holes all over your road.

Bituminous Surface Treatment.—We find in Massachusetts that whenever a road has an average of more than 150 motor cars a day, that it is impossible to maintain, either a gravel road or a waterbound macadam, without some bituminous surface on the top. This can be either of tar or asphaltic oil, never use any oils that have a paraffine base.

You can always tell whether the material you are going to use will produce good results or not, by putting some on your finger and thumb and rubbing them together. If they stick together and you cannot rub it off the finger without the use of pumice stone or your penknife they will stick to the road. If it will wipe off with a newspaper and merely leave your finger greasy and dirty like the grease from your automobile, then it will be no good on the road.

In preparing to apply a bituminous surface treatment always get your covering and spread it on the road side before you start to apply the bitumen. It requires about 10 lb. of gravel or sand covering for every square yard of road surface, when you are using the lighter cold tars or oils and the heavier grades will require from 15 to 20 lb. to the square yard. If possible always spray on your bituminous material with a pressure distributing machine.

Apply about a ⅛ gal. to the square yard, and apply it to only one-half of the width of the road at a time, have your men who are to spread the covering follow right along and spread it quickly and as evenly as possible.

Have them go back and be sure that the whole road is covered and kept covered so that it does not bleed, at any rate for the first week. It costs money to buy bitumen and whenever it is carried off the road it leaves a bare spot that will ultimately cause a hole in a very short time in wet weather, and thereby ruin your road.

The only remedy is to patch the hole at once, by painting it with the same material used with a whisk broom, and then be sure you cover this patch with sufficient material to prevent it from picking up the second time.

Bituminous Materials.—Now in regard to the material, we have got most excellent results with cold tar and material like Tarvia B on both well shaped gravel and macadam roads, but be sure the surface is very firm or hard. The tars set up almost immediately are brittle, do not heal themselves and while they make a most excellent road surface, they should not be used upon any loose or uncompacted road surface. They tend to break and go into pot holes and if these are not immediately patched your road very soon disintegrates and goes to pieces.

The simplest way is to renew the surface film, immediately the underneath part of the road surface is uncovered otherwise a spot starts the size of a dollar which will soon become larger if there is considerable traffic.

The asphaltic oils on the other hand, can be applied to looser and poorer road surfaces, particularly gravel. You can use the asphaltic oils that can be applied cold containing about [illegible] per cent of asphalt.

Apply about [illegible] gal. to the square yard of road surface and cover it, in the manner described above. This treatment can be repeated and when asphalt is used you will find that you can shape your road back in the spring and apply your second surface treatment and you will have a considerable quantity of the asphalt left, so that the results during the second year are much better and more permanent than they were the first. After two or three applications, unless your traffic is extremely heavy, you will find that you have a road surface that may go for a year or two years, without another treatment, always provided you keep it properly patched.

Patching Roads.—Always patch before you get a hole and keep the surface intact. When patching, make the sides of your hole with a little shoulder to hold the material in place, use some patching material either the asphaltic oil used on the road, or K. P., which is a material made of tar that can be used cold, or something like Headly oil which is a fluxed asphalt that can be used cold. Grade your material, using either gravel bank or broken stone with sizes that are at least a half the depth of the hole for the larger sizes and graded down to the very finest sand, say a sand that will pass a 200 mesh. Be sure it is thoroughly mixed and coated before it is put into the hole. Tamp it in and remember that it expands a little with water so leave your hole possibly one-quarter of an inch below the surrounding surface of the road or you will find a bump will develop later.

After the patch is made cover it before you leave it with dry sand, or if necessary, dirt from the road side to keep it from being picked up by passing vehicles. You want to keep your bituminous surfaces on the road and to do this, they must stick to the road firmly.

Gravel Asphalt Roads.—We have had most excellent results in Massachusetts in building what might be called gravel asphalt roads. We have built them since 1912 and they are all in excellent condition today. As we have gone along, we have constantly built them better and stronger because of the increase in heavy motor truck traffic.

In building these roads, the gravel has to be heated and uniformly heated to 250 to 300° F. and the asphalt must be heated in kettles to 300 to [illegible]. The two should then be mixed in some mechanical mixer, preferably a hot mixer; from this it is dumped into the cart and carried to the road and spread.

It is ready to roll, and should be rolled while it is still soft enough to compact thoroughly; this means the temperature of the mixture should be from 90 to 120° F. This part of the work is occasionally troublesome, particularly when the mornings and evenings are cool, because the bottom on the ground and on the top exposed to the air will cool more rapidly than the middle. You cannot roll while the middle is too soft or too hot, because it will then squeeze out ahead of the roller and make waves, so you must wait until you can roll it without having it push out much ahead of the roller.

We have built a good many miles of roads in Massachusetts of bituminous gravel and we think very highly of them, even for a very great volume of traffic, including quite a number of heavy trucks. We have also resurfaced and widened a great many miles of road; by this I mean 75 to 100 miles, where we used the old waterbound macadam road as a foundation, when there were 2 or 3 in. of it still left.

Where the traffic was heavy and we were building a bituminous gravel road, we have, of course, put in a foundation of gravel or field stone where the sub-soil was not good. We have then usually put a crusher into the gravel pit and crushed the larger stone, and perhaps field stone as well, and have laid the foundation of broken stone about 4 in. thick, well shaped and thoroughly rolled. On this, we have spread the mixed gravel and oil, so that it would be about 2½ in. thick, after rolling with a steam roller. Even with good soil conditions, where the roads had heavy traffic, we have used either broken stone or gravel in the sub-base, so that when watered and thoroughly rolled by the steam roller, it would be 4 or 5 in. in thickness.

The top course or wearing surface is just a mixture of asphaltic oil of from 90 to 120 penetration, thoroughly mixed with the heated gravel, and spread evenly so that it would be about 2½ in. thick after rolling. A tandem roller seems to be the best for rolling this material, as it can be used while it is hotter without producing depressions. This mixture usually requires about from 20 to 22 gal. of oil to the cubic yard of loose gravel, the oil being measured hot. The best results are obtained by the use of a gravel, using no size above 1¼ in., but containing the other sizes down to the very finest material. It is advisable sometimes, if you have not enough fine sand in the gravel, to use stone dust or secure some fine sand from elsewhere, as the fewer the voids and the denser the mixture, the better the results. You do not need to infringe the Warren patent specifications. Here, again, the finer the material, the greater the quantity of asphaltic oil that must be used per cubic yard and the stiffer the asphalt that should be used. Roads built of these surfaces have withstood very heavy traffic where the foundations are good from 8 to 9 years already, and are still in good condition.

These roads should be built at least 18 ft. in width, even with good material in the shoulders; with poor material, they should be 19 or 20 ft. in width to prevent having the sides cut off. A ¼ in. crown to the foot is better than a ½ in. crown. We now have a practice of banking all the corners and curves where it is physically possible and giving them a grade from the outside to the inside of ½ to ¾ in. to the foot of width. When we first began the work, we used California asphaltic oil with good results, and since then we have used Texas, Mexican and other asphaltic oils with very good results.

Originally, these roads cost no more, and usually a little less, than waterbound macadam, and they were much more economical to maintain and withstood automobile traffic and motor traffic much better.

They originally cost about 60 ct. per square yard, including the broken stone or gravel bottom, but not including grading, foundation or drainage. Last year the cost for the surface ran up to $1.25 to $1.50 per square yard, materials, teams and labor having advanced in price.

Traffic Sand and Oil Roads Will Stand.—It is hard to predict just what traffic, sand and oil roads will withstand. They have now stood for 12 years in reasonably good condition on roads that had 600 to 800 automobiles a day, 47 to 70 2-horse teams a day, and an average of about 38 trucks a day. They have had go over them without any noticeable damage quite a few motor trucks carrying oil or gasoline that would weigh up to 14 tons, including truck and load.

The gravel and oil mixed roads, and those that have been resurfaced with gravel and oil, have stood satisfactorily for 6 to 8 years with much heavier traffic than this, especially in trucks. I have in mind one section in particular that was constructed and opened up to traffic leading directly to Camp Devens, where, as you perhaps know, they had a cantonment for about 30,000 soldiers. It had some days as many as 700 trucks going to that cantonment, and when they built a very large hospital there, they moved from 30 to 40 lumber trucks, weighing 12 to 13 tons, including the load, over that road every day. This made very heavy traffic, indeed, for the two years that the road has been built. I think I am safe in saying that this road has never shown any signs of weakness or needed any patching whatever.

A blanket coat of hot oil on macadam will carry a much larger number of teams if there is a ratio of two to three automobiles on pneumatic tires to each team to keep the bituminous surface constantly rolled down when the horses and teams pick it up. But note that a very few teams on narrow tires, or a few very heavy teams every day, will destroy the surface if the load is heavy to shear down entirely through the surface to the stone.

If this process is repeated once or twice a day, a rut soon develops and the road becomes muddy and the bituminous surface is rapidly disintegrated. Light oil or cold tar will then be more serviceable, laying dust while the stone takes the wear.

We have maintained a few miles of road in reasonably satisfactory condition with annual applications of a cold tar or water gas tar. They have required ½ gal. per square yard annually, and the results have been about the same and certainly no better than where we have applied two ¼ gal. coats per square yard of light asphaltic oil the first year and ¼ gal. per square yard each succeeding year. The cost for the cold tar has been more.

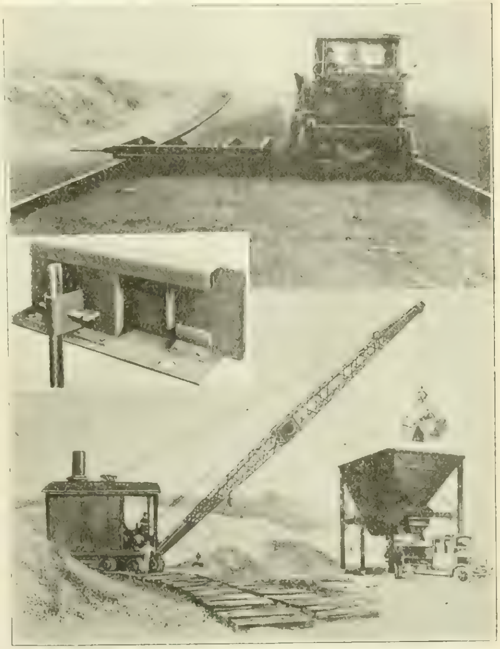
Invariably we clean and patch the road first and cover the bituminous material sufficiently to prevent its picking up. We have sometimes tried dispensing with the cleaning and covering but shall not repeat that expensive experiment. We can usually have the light asphaltic oil sprayed onto the roads by motor trucks for 1.2 to 1.5 ct. per square yard, using ⅕ to ¼ gal. per square yard.

The cleaning, patching and covering costs about the same. You must use some bitumen on the surface of either a gravel or a waterbound macadam road, if there are any motor vehicles using the road every day, say over 100.

New Road Building Equipment

Some new equipment for road building brought out recently by the Blaw-Knox Co., Pittsburgh, Pa., is shown in the accompanying illustration.

The truck turntable occupies a space at one side of the road of only 8 ft., and in turning one end projects over the road form. It is mounted on a skid which enables it to be moved without tearing up the subgrade. A truck after being driven on the turntable is secured from tipping by supports at each end of the table. When the truck is ready to be turned, a lever is operated which folds up these supports and then acts as a push bar by means of which one man can turn a 5-ton truck loaded with 4 yd. of material. The runways which support the truck are mounted on a circular track of less diameter than the width of the truck. This track is placed immediately above a similar circular track which is rigidly secured to the skids. Between these tracks are a series of rollers so that there are no axles to cause friction. A center pin, rigidly secured to the skid which supports the lower track, holds a spider which keeps the rollers in place and also holds a central bearing for keeping the upper track properly centered.



Turntable, Improved Road Form and Steel Storage Bin With Adjustable Measuring Batcher.

The road forms are made of the highest grade No. 9 gage blue annealed open-hearth steel plate, flanged top and bottom, and reinforced with five specially-designed heavy stiffening plates, the 6 in. size weighing approximately 9 lb. per ft. net, or 10½ lb. per ft. including the stakes; other sizes in proportion. The bottom flange of these forms is flat (4⅛ in. wide) and designed to give great bearing surface. The top flange is 2½ in. wide, with a 1⅛ in. stiffening edge. The patented Blaw-Knox slip-joint connection and all other parts are securely riveted, each part being integral with the form. Wedges or keys are designed to be left permanently in place, if desired, as an integral part of the road form, depending on conditions and requirements of the work. "Improved C" road forms are made in standard 5 and 10 in. lengths and in heights varying from 5 to 9 in. inclusive, larger sizes if desired. The steel bin and adjustable measuring batcher is [illegible] from [illegible] tons to 75 and 100 tons and larger. The bins are stated to weigh less than steel bins of equal capacity and to occupy less space when dismantled. The batcher is made entirely of steel and is located [illegible] beneath the bin. This batcher is unique in that it also includes the bin gate [illegible]. When the storage bin gate is closed the material in the batcher is struck off at the same time. The right volume is thus [illegible] in the batcher. When the batchers are full and the storage bin gate closed, it is stated that one operator can dump one, two, three, or four of the batchers at the same time, thus loading a 4-compartment truck with sand and stone in less than [illegible] seconds. Only one workman is necessary to operate a [illegible] capacity bin having four measuring hoppers of sand and four measuring hoppers of stone. The batcher consists of two parts, a top cone and a lower section. The top cone [illegible] within the lower section and an adjustment of a fraction of a [illegible] can be obtained at will.

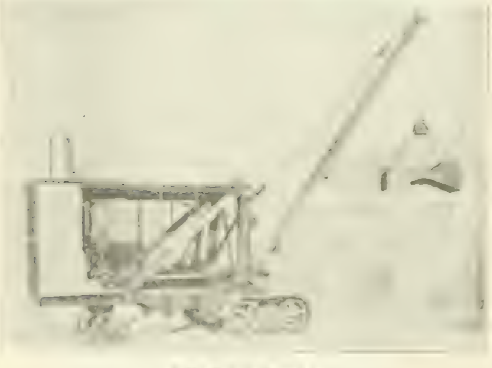
A New Device for Unloading Hopper Bottom Cars

The [illegible] Manufacturing Co., Chicago, Ill., manufacturers of conveying machinery, has perfected a portable reciprocating feeder to take care of materials received in hopper bottom cars. It is claimed this feeder eliminates the digging of pits and that cars can be unloaded at a point most convenient to where the materials are required. This machine operates along the track and handles sand, stone, gravel, coal, etc., thus saving the labor of several men. It is mounted on roller bearings and can easily be slipped under the car. A motor or engine is mounted on platform making it a complete unit. There are no complicated parts to get out of order. It is stated that one man can easily handle the job of unloading and delivering the materials to any style of loader or elevator.

New Auto Crane

A [illegible] crane, designated as Auto Crane Model 4, has been brought out by the Byers Machine Co., Ravenna, O. Among the important features of this crane are the banked levers, operator's raised platform, heavy frame, reinforced A-frame and mast, 42-in. boiler, semi-enclosed cab, gear-driven swinger, steel outrigger nuts and swiveling feet, steel shoes for caterpillars, [illegible], steel coal and water tank (120 gal.), steel boom, three-point suspension truck, all sheaves 16 in. (interchangeable).

The machine has a capacity of [illegible] lb. at 10 ft. on double line; [illegible] at 20 ft.; and 5,500 lb. bucket



Auto Crane Model 4

line load at 20 ft. on single line. The boom is [illegible] ft. long for bucket work, with special boom up to 50 ft. for [illegible] work. The length of the car body is 17 ft. 2 in., and its width is [illegible]. The height from ground to top of A-frame above is [illegible]. The [illegible] are easily removed where [illegible] are required. The complete weight of the machine without bucket is 14 tons. The crane is furnished with either steam, gasoline or electric power plants.

Road Builders Truck

A new truck designed especially for road building operations has been recently placed on the market by the Four Wheel Drive Auto Co. of Clintonville, Wis., manufacturers of FWD trucks. One of the features of this new truck is its short wheel base of 105 in. giving it a short turning radius. This truck is designed to carry a 3 batch body of 3 tons

New F. W. D. Truck

capacity, the body to be operated by a horizontal hydraulic hoist and the tail gates to be operated individually. The truck is also designed to be used as a tractor for trailing loads to the concrete mixers and for hauling road machinery.

Industrial Notes

C. V. R. Fullenwider [illegible]

The Barber-Greene Co., manufacturers of standard [illegible] handling machines, Aurora, Ill., has added the Good Roads Supply [illegible]

The Asphalt Association, [illegible]

William C. Sargent, [illegible]

Trade Publications

[illegible]

Graders.—[illegible]

Truckmixer.—[illegible]

Sand and Gravel Equipment.—[illegible]

Road Repair Outfits.—[illegible]

Industrial Locomotives.—[illegible]

Street Cleaning Apparatus.—[illegible]

Waterworks and Hydraulics Monthly Issue

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Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Management and Office System

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The City Engineer As a Promoter of Public Works

A few weeks ago the editor had the pleasure of listening to an address by the city engineer of Los Angeles, Mr. John A. Griffin, before the Los Angeles chapter of the American Society of Civil Engineers. Mr. Griffin urged local engineers to assist him in arousing the public to a realization of the danger to health that existed in many parts of the city because of inadequate sewer pipes. He showed many lantern slides of sewage flowing in gutters, because the sewers were inadequate during rainy weather. He told of the difficulty of securing money with which to enlarge the sewer system, in spite of the demonstrable menace to health.

As Mr. Griffin talked, the editor wondered how many other city engineers in America are in similar distress. How many cities are there that have fallen behind in public works construction? The number is certainly large. Elsewhere we print a few replies to a letter of query on this subject—enough to indicate that there is no slight amount of arrearage in city improvements. We shall print more letters a month hence, and we invite correspondence from all who read this article.

In estimating whether there is any arrearage of municipal construction, the total money expended each year should be divided by the relative cost of construction based on the year 1913 or 1914 as 100 per cent. In the absence of any construction cost "index," the following factors may be used:

Year.	Relative Construction Cost.	Year.	Relative Construction Cost.
1913	1.00	1918	1.60
1914	1.00	1919	1.90
1915	1.00	1920	2.20
1916	1.20	1921	2.00
1917	1.30		

When annual construction expenditures are divided by such factors, surprises frequently result, for it is difficult to avoid comparisons merely in dollars, and such comparisons may be very deceptive.

The average American city grows 2 per cent yearly; hence, if 1913 was a normal construction year, 1921 should show 16 per cent more construction merely to take care of the growth of population. This growth factor is apt to be overlooked in considering whether recent years have been normal construction years. In a later issue we shall show that public works construction for the country as a whole has been subnormal for seven years.

It would be well were every city engineer to tabulate the expenditures for each class of construction in his city for the past 10 years or more; and reduce it to the pre-war price basis. Then he could show definitely to his city the construction arrearage, if any.

His next step should be to enlist the aid of local engineers in showing the public what should be done. Teaching the public its real needs is not all that must be done. In many cases the city is up to limit of bonded indebtedness, and either new property valuations are imperative or the limitation on the bonded indebtedness should be raised. Letters from several city engineers (printed on another page) complain of bond limitations. This is a serious matter in many cases, for pre-war valuations of property still exist, yet construction costs are, and will remain, above pre-war levels.

We shall be glad to send to any engineer a pamphlet on "Past and Future Wage Levels," which is a reprint of an article in our issue of Aug. 3, 1921. A study of the data there given will enable an engineer to forecast future wage levels with considerable accuracy. The engineer who aims to guide the public should be able to show why he believes that the general level of wages and prices will go little, if any, below what it now is.

Many city engineers are inclined to wait for property owners to propose new construction, but there is a growing feeling among engineers that the engineer should lead the public rather than be led by it. Indeed, the engineer's future status depends largely upon his ability to assume such leadership. The engineer should be more than a designer and supervisor. He should be a promoter of construction that is economically needed. Who, in fact, is more competent to pass upon the economic needs of a city as to pavements, sewers, waterworks, etc., than is the engineer who designs such plants?

Wages of Common Laborers 1913 to 1921, and Probable Future Wages

In comparing labor costs it is frequently desirable to know the rates of common labor wages for different years. The best statistics on this subject are those published by the government in the Monthly Crop Reporter, for common labor on the farms throughout America. The wages are given for every state, both with and without board. The day wages without board, not at harvest time, should be increased about 20 per cent to get the average wages paid by contractors on construction work.

The following is from the November, 1921, issue of the U. S. Monthly Labor Review:

The great change that has taken place within the past year in the wages of farm labor is shown in the September Monthly Crop Reporter. The following figures are taken from that publication, those for 1921 being indicated as preliminary:

AVERAGE WAGES OF MALE FARM LABOR 1913 TO 1921

Year	By the month. With board.	By the month. Without board.	Day labor, at harvest. With board.	Day labor, at harvest. Without board.	Day labor, not at harvest. With board.	Day labor, not at harvest. Without board.
1913	$21.38	$30.31	$1.57	$1.94	$1.16	$1.50
1914	21.05	29.88	1.55	1.91	1.13	1.45
1915	21.26	30.15	1.56	1.92	1.13	1.47
1916	23.25	32.83	1.69	2.07	1.26	1.62
1917	28.87	40.43	2.08	2.54	1.56	2.02
1918	34.92	48.80	2.65	3.22	2.07	2.63
1919	39.82	56.29	3.15	3.83	2.45	3.12
1920	46.89	64.95	3.60	4.36	2.86	3.59
1921[1]	29.48	42.65	2.12	2.80	1.60	2.17

[1] Wages for 1921 are indicated as preliminary.

The forthcoming "Handbook of Construction Costs," by Gillette, will contain corresponding wage data by years back to 1866 for the different states.

The following are the average rates of hourly wages for common labor paid in the iron and steel furnaces and mills:

Year.	Wage.	Year.	Wage.
1907	$0.151	1914	$0.181
1908	.147	1915	.180
1909	.145	1916	[illegible]
1910	.158	1917	.298
1911	.161	1918	.461
1912	.162	1919	[illegible]
1913	.181	1920	.508

The following are the hourly wages of common labor paid by the U. S. Steel Corporation in the Pittsburgh district, beginning on the dates given:

Date.	Hourly wage.	Daily wage.	Index number
[illegible]	$0.20	$2.00	100
[illegible]	.22	2.20	110
[illegible]	.25	2.50	125
[illegible]	.275	2.75	138
1917 May 1	[illegible]	3.00	150
[illegible]	[illegible]	3.30	165
1918 Apr. 16	[illegible]	3.80	190
[illegible]	[illegible]	4.20	210
[illegible]	[illegible]	4.62	231
[illegible]	[illegible]	5.06	253
[illegible]	[illegible]	4.07	204
[illegible]	[illegible]	3.70	185
[illegible]	[illegible]	3.00	150

Up to Oct. 1, 1918, the basic day was 10 hours; thereafter till July 16, 1921, it was 8 hours, with time and a half for overtime. But after July 16, 1921, the 10-hour day was restored. The index number is not on the hourly basis between Oct. 1, 1918, and July 16, 1921, but is based on the 10-hour day with the time and a half payment for overtime.

It will be seen that the farm hand wages in 1921 averaged slightly less than 40 per cent in excess of 1913, also that the common labor wages in the Pittsburgh mills are now exactly 50 per cent above the 1913 average.

In this connection it should be noted that the per capita money in circulation is almost exactly 50 per cent in excess of that in 1913, thus bearing out Mr. Gillette's wage level forecast published in our issue of Aug. 3, 1921. But it should be remembered that our per capita gold is now 80 per cent in excess of that in 1913; and that with the revival of business now in progress there will result an increase in Federal Reserve notes (paper money) which will cause, first, a rise in prices and later, a rise in wages.

Immigration is now greatly restricted by law, so that with a general revival of business we shall have a growing scarcity of common labor and a consequent rise in price of that grade of labor in excess of the rise in other grades. It is our opinion that we shall not see common labor at as low a wage rate as it now is for many years to come, unless the immigration bars are lowered; and even then it is likely that common labor wages will reach a level 80 per cent above the 1913 level, because the per capita gold is 80 per cent above that in 1913 and is likely not to decrease.

Every contractor who signs a contract this spring takes a risk that he will have to pay higher wages before the year ends. Any contractor whose contract can not be practically finished before next year is likely to be even more out of pocket if he figures the job on the basis of present wages for common labor.

In this connection it is well to remember that the average cost of living was 60 per cent above the 1913 level last January, and that food prices are rising.

Is the Price of Cement Too High?

A good many engineers are of the opinion that portland cement prices are higher than they should be. During the last week in February the average price of cement at all the mills in the country was about $1.80 per barrel (exclusive of bags), as compared with $1.00 for 1913. For the mills of the middle states the price averaged $1.70, as compared with $1.05 for 1913, indicating an increase of 62 per cent. As nearly as we are able to ascertain, the present cost of living averages 60 per cent above the level of 1913; the wages of union labor average 60 to 65 per cent above the 1913 level; the wages of common labor average 50 to 60 per cent above the 1913 level; the wholesale price index of 326 commodities in January was 48 per cent above the 1913 level, according to the U. S. Bureau of Labor; and, according to the same authority, the wholesale price index of all building materials were 102 per cent above the 1913 level. By comparing, in this manner, relative price and wage charges an approximately correct conclusion can be reached as to the reasonableness of cement prices; but sight should not be lost of two other facts: (1) The price of coal is 80 per cent above the 1913 level and (2) the average freight rate is 75 per cent above the 1913 level.

In our issue of April 6, 1921, we published an elaborate detailed analysis of the estimated and actual costs of manufacturing cement, in which it was shown that fuel and power constituted 50 per cent of the "direct expense" of producing cement. It follows, therefore, that with both coal and freight at the present prices, any further reductions in the price of cement can be expected only to a limited extent, and probably but for a short time.

In our issue of Dec. 7 we published a great amount of statistical information relative to the cement industry for the past 40 years, including prices, costs of production, etc. It was shown that the per cent of margin between the selling price and the mill cost in the Lehigh Valley district averaged less than 10 per cent for the years 1918 to 1920, as compared with 14.5 per cent for the years 1913 and 1914; yet 1913 and 1914 were years of low prices for cement, whereas for 1918 to 1920 cement averaged 60 per cent higher in price.

We can not too often repeat the fact that our per capita currency is now 50 per cent above the 1913 level, and that per capita gold is 80 per cent above the 1913 level. For the past 80 years wage rates in America have been closely proportional to the per capita currency, as shown in our issue of Aug. 3, 1921. In view of the fact that our per capita gold is 80 per cent above the pre-war level, and in view of the fact that both the volume of paper money and of bank credits tend ultimately to follow the volume of gold, it is highly probable that general wage levels will not decline appreciably from the present level. If so, the wholesale commodity price level will soon rise, and with it will rise all prices now below that level, such as the prices of steel and copper.

Engineers who aim to advise their employers and the public correctly as to the reasonableness of construction material prices should study the price level formula (Engineering and Contracting, April 7, 1920) and the wage level formula (Aug. 3, 1921) for these have been shown to accord with past levels of prices and wages and may, therefore, be accepted as the best guides for forecasting the future. There is a tendency to reason that because some commodity like structural steel or copper is now close to the pre-war level, therefore, all other construction materials will soon reach the same low level. No greater economic mistake can be made than through such a reasoning.

Municipal Records Are Opened to the Public by California Supreme Court

The refusal of municipal officers to permit inspection of their records and other papers by persons having a legitimate interest is a comparatively rare occurrence, but one involving much harm in certain instances.

Without knowing that a legal decision was being rendered at about the time of our writing, we printed in our issue of December 14, 1921, an editorial entitled, "The Los Angeles Aqueduct and Power Scandal," in which we quoted a Los Angeles city councilman speaking on the council floor relative to the Board of Public Works as follows: "Having been denied access to the books and records of the bureau, my analysis must necessarily be in general terms." This indicated a lamentable condition, and we confess to a real pleasure in noting in the December, 1921, issue of "The City," the publication of the San Francisco Bureau of Governmental Research, that the Supreme Court of California has ruled that, with certain specific exceptions, such records shall be open to reasonable public inspection. "The City's" statement of the matter follows:

The right of citizens to inspect municipal business, not after it is settled, but while it is in the formative stage when criticism may be of real value, is at last definitely established. Last week the Supreme Court of California, in the Bureau's Hetch Hetchy suit against the city and county of San Francisco, handed down a decision ordering that all the records and data sought by the Bureau in its action be made available to it for inspection. This is of far-reaching importance, as it settles in favor of the taxpayers the right of citizens to take an active part in their own affairs as administered by municipal officials.

The Bureau in 1917, wishing to make an independent and accurate study of the Hetch Hetchy project, after informal, and later formal requests, was denied access by the City Engineer to certain information relative to diamond drill borings, dam location plans, cost estimates, stream flow studies, etc. The City Engineer's recommendation that the Bureau be denied the requested information and opportunity to scrutinize records, estimates, etc., was supported by the Mayor and upheld by the Board of Supervisors after formal hearing.

Two suits were then filed, one by the Bureau in its own name and one by the secretary of the Bureau, as a taxpayer. A trial was had before Judge Crothers, and the court handed down a decision upholding in part the Bureau's contentions, but deciding that certain kinds of data need not be open to inspection. The city appealed from this decision, and the Bureau appealed from that part exempting "working papers," inasmuch as all data and investigations that had not been formally filed with the Board of Public Works by the City Engineer, and all data turned over to the City Attorney for his information in trial cases would have been exempt from citizen scrutiny if the decision were permitted to stand. (The city contended that working reports and other data did not become public documents until they had been transmitted in a formal report from the City Engineer to the Board of Public Works, and further, that all data, when turned over to the City Attorney, became "confidential" in character.)

In the meantime, the Bureau and the City Engineer were in conferences on many other matters; much of the data originally sought by the suit had been made available at various times to the Bureau's representatives and to citizens generally, and specifications had been published and the contract let for construction of the dam. The suit was not dropped, however, because of the public-spirited desire to definitely estabiish the right of all citizens to have a knowledge of all public business, and not only such as a public official might choose to disclose or as might be disclosed in formal official reports.

This right is definitely established by last week's decision, which orders included within the writ of mandate for citizen inspection all preliminary estimates and details which form uncompleted data, even although such matter may not yet have been formally dignified by official sanction as public records and further, that citizen inspection of records and "other matters" cannot be prevented on the ground that they are "confidential" by the circumstance of the City Engineer [illegible] the City Attorney.

Index Numbers of Wholesale Prices 1913 to January 1922

The accompanying tabulation shows the index number of wholesale prices by groups of commodities, as computed by the U. S. Bureau of Labor Statistics. The group of miscellaneous commodities includes such important articles as cottonseed meal and oil, lubricating oil, jute, rubber, newsprint and wrapping paper, rope, soap, laundry, starch, tobacco, Manila hemp, sisal, phosphate rock and wood pulp. The commodities, composing the other groups, are as indicated by the title:

INDEX NUMBERS OF WHOLESALE PRICES IN SPECIFIED YEARS AND MONTHS, 1913, TO JANUARY, 1922, BY GROUPS OF COMMODITIES.

(1913—100.)

Year and month.	Farm products.	Food, etc.	Cloth and clothing.	Fuel and lighting.	Metals and metal products.	Building materials.	Chemicals and drugs.	House furnishing goods.	Miscellaneous.	All commodities.
1913	100	100	100	100	100	100	100	100	100	100
Jan	97	99	100	103	107	100	101	100	100	100
April ..	97	96	100	98	102	101	101	100	98	98
July	101	102	100	99	98	101	99	100	101	100
Oct.	103	102	100	100	99	98	100	100	100	101
1914	103	103	98	96	87	97	101	99	99	100
Jan.	101	102	98	99	92	98	100	99	99	100
April ...	103	95	99	98	91	99	100	99	101	98
July	104	104	99	95	85	97	99	99	97	100
Oct.	103	107	97	93	83	96	105	99	96	99
1915	105	104	100	93	97	94	114	99	99	101
Jan.	102	106	96	93	83	94	103	99	100	99
April	107	105	99	89	91	94	102	99	99	100
July	108	104	99	90	102	93	108	99	98	101
Oct.	105	103	103	96	160	93	124	99	99	101
1916	122	126	128	119	148	101	159	115	120	124
Jan.	108	113	110	105	126	99	150	105	107	110
April	114	117	119	108	147	101	172	108	110	117
July	118	121	126	108	145	99	156	121	120	119
Oct.	136	140	138	133	151	101	150	124	132	134
1917	189	176	181	175	208	124	198	144	155	176
Jan.	148	150	161	176	183	106	159	132	138	151
April	181	182	169	184	208	114	170	139	119	172
July	199	181	187	192	257	132	198	152	153	186
Oct.	198	183	193	146	182	114	252	152	163	181
1918	220	189	239	163	181	151	221	196	193	196
Jan. ...	207	187	211	157	174	136	232	161	178	185
April	217	178	232	157	177	146	229	172	111	190
July	224	184	249	166	181	154	216	191	190	198
Oct.	224	201	257	167	187	158	218	226	196	204
1919	234	210	261	172	161	192	179	236	217	212
Jan.	222	207	234	170	172	161	191	218	212	203
April ...	235	211	217	167	152	162	178	217	216	203
July	246	216	282	171	158	186	171	245	221	218
Oct.	230	211	313	181	161	231	174	264	220	223
1920	218	236	302	238	186	308	210	366	236	243
Jan. ..	246	253	350	184	177	268	189	324	227	248
Feb. ..	237	241	356	187	189	300	197	329	227	249
March	239	246	356	192	192	324	205	329	230	253
April .	246	270	353	213	195	341	212	321	238	265
May ...	244	287	347	235	193	341	215	329	246	272
June .	243	279	335	246	190	337	218	362	247	269
July .	236	268	317	252	191	333	217	362	243	262
Aug. ...	222	235	290	268	193	328	216	363	240	250
Sept.	210	222	273	284	192	318	222	371	239	212
Oct. ...	182	204	257	282	181	313	216	371	229	225
Nov. . .	165	195	234	258	170	274	207	369	220	207
Dec. ...	144	172	220	236	157	266	188	346	205	189
1921:										
Jan. .	136	162	208	228	152	239	182	283	190	177
Feb.	129	150	198	218	146	222	178	277	180	167
March ..	125	150	192	207	139	208	171	275	167	162
April ..	115	141	186	199	138	203	168	274	154	154
May	117	133	181	194	138	202	166	262	151	151
June	113	132	180	187	132	202	166	250	150	148
July	115	134	179	184	127	200	163	235	149	148
Aug.	118	152	179	182	120	198	161	230	147	152
Sept.	122	116	187	178	120	193	162	223	146	152
Oct. ...	119	142	190	182	121	192	162	218	145	150
Nov.	114	142	186	186	119	197	162	218	145	149
Dec. ..	113	139	185	187	119	203	161	218	148	149
1922:										
Jan. ...	116	134	183	183	117	202	159	214	146	148

Public Works Construction to Provide Employment.—Cities of the northwest, as Spokane, Seattle and Portland, are trying to provide work for their own residents by hastening construction of public works and other emergency measures, but they are warning all outsiders of the scant possibility of finding work if they come there.

Water Supplies of New Jersey.—According to the 1921 report of the Bureau of Engineering of the New Jersey State Department of Health approximately 46 per cent of the urban population of that state receive filtered surface water, 31 per cent surface water which has only been chlorinated, and 1.5 per cent untreated surface water.

Diagram for Hydraulic Computations

To the Editor: I note in your issue of February 8th, page 128, under the heading "Kutter's Formula Simplified," that there is claimed a saving of much time by the use of a modification of the formula.

Can it be possible that any of your readers spend their time in such laborious computations? I should be no less surprised at a suggestion that engineers wishing to travel from Boston to New York, instead of walking the entire distance, should use roller skates.

The actual solving of Kutter's formula throughout any extensive hydraulic computations would be a task analogous to walking from Boston to New York, the use of the excellent modified formula referred to above would be analogous to the delightful and speedy trip over the road on roller skates. But fast express trains have been carrying busy engineers from Boston to New York while they sleep, and with as little effort on their part as is involved in the use of one of the many available diagrams for the solution of Kutter's formula.

I am enclosing such a diagram from which in about 10 seconds without the use of a straight edge, slide rule or any other device, the formula can be solved for any one of the four variables: Velocity, Slope, Hydraulic Radius or Roughness.

I believe that the sum total of unnecessary labor in engineering offices on account of failure to use graphical methods in one way or another is very large.

The enclosed diagram is one of a set which I prepared and published in 1913 when I had more spare time than I have ever had since.

KARL R. KENNISON,
Consulting Engineer.

Boston, Mass.

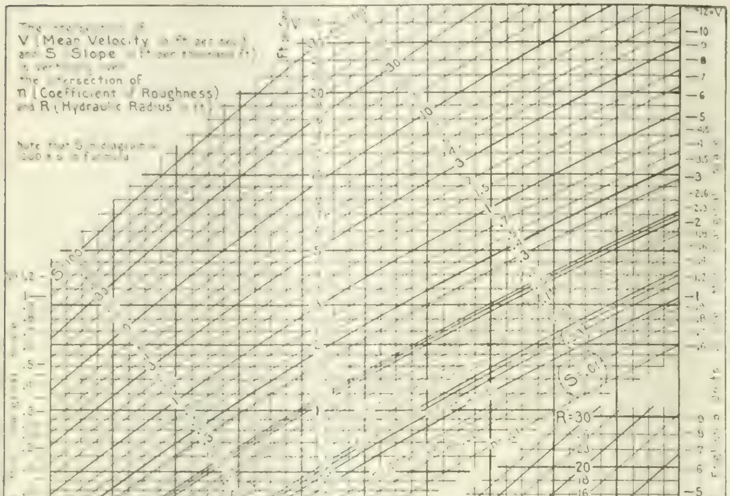


Diagram for Calculation of Flow of Water by Kutter Formula.

[illegible] well laid brick- [illegible] earthen canals in good order [illegible] earthen river beds in bad [illegible]

A Sand Well Problem

To the Editor: The city of Crown Point, Ind., during 1921 constructed several tubular wells at its water plant, each well 150 ft. deep and 8 in. diameter. The log of the wells shows 20 ft. of clay, 80 ft. of exceedingly fine water bearing sand and 50 ft. of very compact clay (so-called shale). Twenty-five feet of screen was set in the 8-in. pipe so that the bottom of the screen would be even with the bottom of the sand or top of shale. About this 8-in. pipe and previous to its setting a 12-in. casing was set to the bottom of the sand. After setting the 8-in. pipe the 12-in. casing was gradually withdrawn, the space between it and the 8-in. pipe being filled with a torpedo gravel as fast as the pumping of the sand from the 8-in. pipe would permit the settling of the gravel. Probably 15 cu. yd. of gravel was thus fed around the screen during the withdrawal of 25 ft. of the 12-in. outer casing. The purpose of the torpedo sand was to aid the screen in excluding the very fine sand.

The wells are equipped with and operated with air lifts set 148 ft. deep and having an average of 110 ft. working submergence. Since being actively operated under a discharge of around 150 gal. per minute per well the sand continues to discharge at as high a rate as 1 cu. yd. per well per week. It should be mentioned that these wells operate intermittently at a rate of about two hours on and one hour off during the day and at one-half that rate at nights.

It was supposed the screen was sufficiently encased in the gravel to exclude the sand, but it evidently is not. We would like to have opinions as to where the sand comes in. Did the torpedo gravel form a pyramid about the screen on top of the shale and does the sand come in above this settling pyramid of gravel? Or did the gravel fail to settle against the inflow of sand during the feeding process, and does the sand come in beneath the torpedo gravel? Or what is the probable position of the gravel?

F. L. KNIGHT,
City Engineer.

Crown Point, Ind.

Sewer Improvements at Los Angeles.—Council of Los Angeles, Calif., is considering $3,500,000 bond issue for sewerage.

Municipal and Privately Owned Waterworks

To the Editor: Your editorial on page 124 of your Feb. 8 issue is interesting and valuable, because it will lead to speculation tending to produce economical operation of waterworks.

It is impossible to make a general comparison of the relative efficiency of operation between privately-owned and publicly-owned waterworks. The writer is of opinion that with very large plants municipal ownership has a material advantage, but for plants in towns with populations of 25,000 and under, the privately-owned works has a great advantage, but there is no fixed and invariable rule. There are many water works in towns of 100,000 and over, where the management is vitally defective and occasionally one with a population below 20,000 is an excellent example of efficient handling. In nearly all cases the success or failure depends upon the man in absolute charge. If a municipality is fortunate enough to have its work under a water supply engineer who possesses resourcefulness, ability and interest in his job and does not hamper him but adopts his recommendations in all cases, it can depend upon a successful outcome, but in too many cases the man in charge is not taken seriously. The works are operated for political expediency and when the engineer has to be guided by political methods and suggestions mathematics and engineering principles cut very little figure.

With a privately-owned waterworks, however, efficient management and operation are essential to prevent failure, the only disadvantage being that the private corporation is not in as good a position to raise money for essential improvements as the municipality.

For a small municipally-owned works, where matters are in charge of a council whose positions are of short tenure and obtained more on account of their popularity than ability, they seldom understand the importance of putting their waterworks in complete charge of a man of ability, because such a man usually commands a higher income than they can appreciate necessary; therefore, their economy is ruinous.

With our present form of municipal organization no remedy seems possible.

I venture to say that if a capable waterworks engineer were to visit and inspect municipally-operated water works, in nine out of ten plants in towns of 15,000 and under, he would find serious deficiencies that it would pay handsomely to correct. In one place there is a shortage of water at every dry season; in another place the filter plant is so badly managed as to be practically of no use. In another place the pumping plant is using double the amount of fuel necessary. In another place the supply mains are so badly tuberculated that the capacity is reduced by 50 per cent. In another case only 50 per cent of the water furnished can be accounted for; the balance is being wasted through defective mains or services. In another case the rates for water are not sufficient to pay the operating expenses and fixed charges, and the deficiency must be made up by taxation. In another case the water furnished discolors laundry, attacks the mains and produces what is known as the "Red Water Plague." In another case the dam or reservoir is leaking so badly as to be a constant menace. In another case the standpipe is so badly rusted as to endanger the system, and in another case the fire service in certain parts of the town is grossly inadequate. In another case the rates are so badly planned as to put the majority of the consumers under a disadvantage, in order to favor a few people with a pull. In another case the town is taking water from a grossly polluted or inadequate source when they could very advantageously adopt a supply of unquestioned superiority and economy. In some cases many of these defects are combined.

These are only a few of the probable deficiencies that such an inspection would note.

To make a mathematical comparison between a municipally and privately operated waterworks, it is necessary to assume the same conditions of efficiency. As soon as we make any other assumption we cannot tell where to stop, so that a comparison then would be of no value.

J. W. LEDOUX,
Philadelphia, Pa. Consulting Engineer.

Confirmation of Price Changes Formula

To the Editor: I am sending you my argument in justification of your much discussed formula for predicting price changes, which formula impressed me as being entirely logical. When the same conclusions are reached from two very different procedures of logic, I should think that confirmation of the formula is strongly evidenced.

As prices are variable, supply and demand are variable. Therefore, it is really the rate of supply and demand change that determine prices. As the rate of money-turnover is the factor that causes rate change in supply and demand (being a barometer to the rate of demand) it follows that if the rate of money-turnover is used as an equalizing or stabilizing ratio to prevent or absorb imbalance between supply and demand so that their rates of increase or decrease are in relative uniformity, we can derive a formula for price change—as all rates are simply ratios and ratios can be combined to compose a formula.

Here we have three rates or ratios: supply, demand and rate of money-turnover.

If we use currency per capita as demand, and average productive efficiency as supply, and the rate of money-turnover as the factor to keep these balanced, then by having a standard year, we can determine by formula prices in advance with approximate accuracy, depending upon the accuracy and quantity of our statistics.

As the wholesale sale is the point of contact between demand and supply, then the ratio of the anticipating index to average prices will be the index to average wholesale prices.

Quantitative statistics have the same value for removing the human or uncertain factor from economics that they have in life insurance science.

RICHARD OLNEY EUBANK.
Detroit, Mich.

Changes in Retail Cost of Food

The U. S. Department of Labor, through the Bureau of Labor Statistics, has completed the compilation showing changes in the retail cost of food in 15 representative cities of the United States.

During the month from Jan. 15, 1922, to Feb. 15, 1922, there was a decrease in eight of the fifteen cities, as follows: In Manchester 2 per cent; in New Haven, Norfolk and Rochester, 1 per cent; in Atlanta, Bridgeport, Cincinnati and New York, less than five-tenths of 1 per cent. In the other seven cities there are the following increases: In Butte, Los Angeles and Washington there was an increase of 1 per cent. In Boston Newark, Philadelphia and San Francisco there was an increase of less than five-tenths of 1 per cent.

For the year period, Feb. 15, 1921, to Feb. 15, 1922, there was a decrease of 16 per cent in Norfolk, 12 per cent in Bridgeport, 11 per cent in Cincinnati, 10 per cent in Atlanta, New Haven and San Francisco, 9 per cent in Boston, Los Angeles, Manchester, Newark and Rochester, 8 per cent in Butte, New York and Washington, D. C., and 7 per cent in Philadelphia.

As compared with the average cost in the year 1913, the retail cost of food of Feb. 13, 1922 showed an increase of 51 per cent in Washington, D. C.; 47 per cent in New York; 45 per cent in Boston; 44 per cent in Philadelphia; 43 per cent in Manchester; 42 per cent in Atlanta and New Haven; 40 per cent in Cincinnati and Newark; 37 per cent in San Francisco; and 35 per cent in Los Angeles. Prices were not obtained from Bridgeport, Butte, Norfolk and Rochester, in 1913, hence no comparison for the 9-year period can be given for these cities.

Tri-State Waterworks Convention.—The Tri-State Waterworks Association of Carolinas and Georgia will hold its annual convention at Spartanburg, S. C., April 19-21. W. F. Stieglitz, Columbia, S. C., is secretary.

What Cities Are Doing in the Construction Line

Improvements Underway and Proposed and Suggestions for Bringing About Resumption of Public Work, Outlined in Letters from City Engineers

[illegible] Program This Year.

[illegible]

[illegible] pro[illegible] and [illegible] We [illegible] building [illegible] another [illegible]

[illegible] situation [illegible]

[illegible] expenditures for [illegible] approved [illegible]

M. F. DULLEA,
[illegible] City Engineer.

Municipal Improvement Program Resumed at Fort Collins.

[illegible] municipal [illegible] three large contracts, [illegible] District No. [illegible] and Mountain Ave. [illegible] concrete paving.

[illegible] west on Mountain Ave. [illegible] parking [illegible] concrete driveway [illegible] which the municipal [illegible]

[illegible] improved by the [illegible] reservoir and [illegible] long [illegible] pipe, thus increasing the [illegible]

[illegible] its present sani[illegible] taken to provide [illegible]

[illegible] miles north [illegible] possible [illegible]

JOHN REVELL,
City Engineer and Assistant
Fort Collins, Colo. Commissioner of Works.

[illegible] Worth of Sewers Built in Last 3 Years in Detroit.

In [illegible] miles, fairly well [illegible] of addi[illegible] sized [illegible]

[illegible] absorbed. [illegible]

JAMES [illegible]
Detroit, Mich. Assistant City Engineer.

Public Improvements at Joplin Furnished Work for 500 Men Last Year.

[illegible] extent during the past seven years. During the year 1921 we built approximately 20 miles of sanitary sewers, ranging in size from 8 in. to 12 in. These sewers were an extension to our old public sewer system. We also built a small septic tank at a cost of $3,000 and are now engaged in constructing a larger septic tank costing $35,000. The entire cost of the sewer extensions and septic tanks is about $300,000. All of this work was done by labor employed directly by the city and only home labor was employed. Approximately 500 men were given work who otherwise would have been unemployed during this past year or who would have been forced to seek work elsewhere.

We now have numerous small lateral sewers under construction and several others projected. Improvements are not being forced on the property owners but they are cooperating with us very nicely in our efforts to keep enough work going to give our unemployed labor some work during this time.

There has been very little paving done in the past three years but we will probably do more during this year.

S. P. ASHCRAFT, JR.,
Joplin, Mo. City Engineer.

Grand Rapids Has Large Construction Program.

Grand Rapids already has begun a large program of municipal work dating back to 1920. 1920 and 1921 were near normal years for quantity of municipal work in Grand Rapids. 1922 promises to be a banner year as we are spending $1,400,000 for 20 miles of new pavement; $100,000 for new sewers; $100,000 for new water mains, and $300,000 for an addition to our filter plant. We are also constructing a new concrete bridge at a cost of approximately $200,000. We are contemplating the reconstruction of our sewage system and the building of a sewage disposal plant in the near future.

Grand Rapids is located in a rich fruit and general farming district and is the distribution center for western Michigan. Its factories manufacture principally the necessities of life and the demand for these necessities did not cease with the war. Grand Rapids has never been a boom town and was not effected by the war, as were other towns of about the same size. Thus, with a retained buying power the people of this city are building new homes, factories and municipal improvements. Such conditions have made "Grand Rapids a good place to live" during this depression.

C. A. PAIGE,
Grand Rapids, Mich. City Engineer.

Contemplates 40 Mile Street Improvement Program.

We contemplate a 40 mile street program for the season of 1922. It is expected that bids will be asked the latter part of the month.

B. L. HARVEY,
Rockford, Ill. Public Engineer.

Omaha Proposes 720,000 Square Yards of Paving This Year.

The only class of improvement on which we have fallen behind much in this city is paving. We have, at present, about 220,000 sq. yd. under contract on which work will begin as soon as weather permits. We received bids on about 190,000 sq. yd. on Feb. 21, which were awarded on Feb. 28. Bids are also to be received on March 14 for about 110,000 sq. yd., and we are preparing plans for probably 200,000 yd. more.

We spent $500,000 for sewers last year. Five per cent bonds, amounting to $500,000, were sold a few days ago at a premium of $34,515. The money will be spent on main sewers for which the city at large pays. In addition, we have plans prepared for a large number of district sewers which are assessed against abutting property.

So far as I can see now we will be caught up pretty well with all public facilities by the end of this year, or at least next year.

HERMAN BEAL,
Omaha, Neb. City Engineer.

Bridgeport Has Special Fund for Work for Unemployed.

We have not shut down completely on street and sewer work during the past few years so that we are not very far behind.

Last year we had a special appropriation of $[illegible] to give work to the unemployed, who were put to work in parks and on streets on public improvements which were mostly labor.

This year we will have to do the same, possibly on a larger scale. In handling this fund the Charities Department acts as a City Employment Agency, giving the preference to those who seem to be most in need of employment.

JAMES A. McELROY.

Bridgeport, Conn. City Engineer.

Municipal Construction Should Be Resumed Now.

Our public facilities, such as water supply system and storm and sanitary sewers systems, have fallen behind in the matter of necessary extensions.

Our trouble is lack of funds, for this city has outgrown its revenue. Our tax rate is too low and our water rates are actually the same as those in effect years before the war. We have under consideration the increasing of the city's revenue.

Advantage should be taken now to resume municipal construction, for the cost of labor is low, and I don't believe the cost of materials will go much lower, if any. Municipal officers should make their surveys, place their house in order and go ahead. What would apply to Montgomery in this connection would not necessarily apply at other cities. What we need is confidence in the future and in our great country and its people, and the nerve to go ahead.

H. A. WASHINGTON.

Montgomery, Ala. City Engineer.

A $11,000,000 Water Plant Bond Issue at Kansas City.

The Water Department of Kansas City has never been able to supply fully the demand for water. There is a movement to vote for bonds to the amount of $11,000,000, to be used in constructing a new plant. These bonds will be voted upon April 4, 1922.

We have kept up with the demand for new sewers and practically so in new pavements and repairs.

ROBERT W. WADDELL.

Kansas City, Mo. City Engineer.

New Haven Proposes to Expend $1,700,000 for Improvements.

In no year since 1914 has there been any decided slackening up of public work in this city. In the past seven years there have been very active seasons in which street paving, sewer work and the construction of bridges have been carried forward vigorously. The water supply is in the control of a private corporation, so I cannot speak concerning matters pertaining to that subject.

During the past seven years there has been spent for new pavements the sum of $1,970,000, which laid over 50.5 miles. For sewers there was spent the sum of $630,000, giving 11.6 miles of new work. For bridges there was expended about $400,000, on 8 structures.

For the year 1922 the amount of $300,000 has been asked for pavements. We are expecting to start the construction of a new bridge this spring, the cost of which it is estimated will be over $1,000,000. Four hundred thousand dollars have been asked for park work.

EDWARD S. NETTLETON

New Haven, Conn. City Engineer.

Has Made Up Its Deferred Construction.

The city of Gloversville fell behind on pavement construction and maintenance during the years 1917 and 1918 and on some sewer construction during the same years. Since that time I think the city has made up nearly all that it lost during those two years on public improvements.

Last year the city spent about $165,000 on construction work and probably will spend that much this year.

H. J. HANMER.

Gloversville, N. Y. City Engineer.

Amendment of State Constitution Suggested to Allow Formation of Improvement Districts.

During the period of the war very little work of any kind was accomplished. This was due probably to three reasons: First, the inability to market the bonds which must be sold at par and accrued interest, the interest being 5 per cent; second, the high cost of such work; and third, the desire to devote all resources to work necessary for the winning of the war.

None of our facilities—waterworks, sewerage, pavements—have kept up in any measure with the expansion of the city.

Such improvements are utterly beyond the ability of the city to finance at the present time, as we have almost reached our bonding limit under the charter.

Aside from a proposal to issue about $2,000,000 in bonds for such improvements, nothing is being done.

In my opinion, the only solution of this matter which would permit of the financing of such improvements as needed would be an amendment to the state constitution authorizing the inauguration of improvement districts in which the improvements would be assessed against the property in accordance with benefits received. In order to make this effective, the Texas homestead law would have to be amended, which as it now stands does not permit the fixing of any lien or assessment whatever against a homestead. A homestead is even exempt from forced sale for state, county or municipal taxes.

We have a state law which permits certain improvement districts being created, such as roads, paving and drainage, the latter applying more directly to country drainage districts, but this would be rather cumbersome of application to municipal drainage problems. The homestead law, however, is an obstacle in all of these problems which cannot be overcome without a vote by the people of the entire state.

On every paving improvement that is undertaken we have this problem to deal with, and if the owner of a homestead has no other property upon which an assessment can be fixed and will not voluntarily secure the paving company for the paving costs, nothing can be done but leave that portion of the street in front of his property unpaved. This is a condition which can be witnessed in every Texas city where some of the best streets have unsightly unpaved strips in the street.

Past experience has shown that it is extremely difficult to secure an amendment to the state constitution due to the indifference of the majority of the people to such questions and will not take the opportunity of looking into the merits of such an amendment and will seek to play safety first by voting against any such proposition. I have no doubt but that in time these difficulties will be overcome but for the present we are sadly hampered in all municipal improvement work.

J. C. McVEA.

Houston, Tex. City Engineer.

Education of Public by Engineer a Means for Causing Resumption of Work.

Paving and sewers were of course to a great extent held up during the war period, but a great part of this has been caught up during 1920 and 1921. The city has at present under consideration three extensive sewer problems which will very likely be started in 1922 and 1923. Inability to repair streets during the war period caused a great deterioration of downtown streets and during 1920 and 1921 very nearly the entire downtown section was resurfaced and more of these streets will be resurfaced this year, and considerable new construction built. Expense of construction also held up track elevation and flood prevention work. Track elevation work is now progressing slowly but it is hoped to be able to continue this elevation as fast as the financial condition of the railroad companies will permit. Plans are now being prepared for the finishing of flood prevention which will necessitate the construction or reconstruction of five bridges.

I believe public work should be carried on just as fast as financial conditions of the city will permit. In view of the fact that the biggest end of the large improvements are of lasting benefit, I am in favor of doing this work by long period bond issue.

I believe the best method for causing a resumption of municipal construction is in education which can best be done by the engineers of the country and the advocating of public work by long term bond issue, which will extend the cost and make the immediate burden as light as possible.

J. L. ELLIOTT.

Indianapolis, Ind. City Civil Engineer.

$600,000 for Sewers at Paducah

Public [illegible] in Paducah have [illegible] fallen appreciably behind in the last few years and [illegible] regular program of construction will be [illegible] 1910 [illegible].

A [illegible] program has been [illegible] to meet the costs [illegible] under way for the construction of trunk line sewers, with possibility of [illegible] to be [illegible] in the next two years.

HENRY A. PULLIAM.
Commissioner of Public Works and City Engineer
Paducah, Ky.

Sewerage and Building Construction at Lincoln.

So far as Lincoln is concerned, we do not feel that our public facilities have fallen behind in the last seven years, with the possible exception of our sewer plant. This latter we are now entirely rebuilding and extending at a cost of something over [illegible]. Our water works have been kept up and extended in practically a normal manner.

We have slackened up in paving during the last three years, having laid about half as much as we did during an equal time before. However, we have over 100 miles of permanently paved streets and feel that it will be no particular hardship if we do proceed rather slowly.

In the line of sewerage, we started construction of a $150,000 intercepting sewer about two years ago, and this will be completed this fall. Sewage disposal plant contracts will probably be let in June. As some 97 per cent of our population is accessible to sewer laterals, we cannot expect any great activity in that line.

In the line of public building I would say that we are about to start construction of a $200,000 city hospital.

GEORGE W. BATES.
Lincoln, Neb. City Engineer.

Muskogee Could Expend $1,675,000, But—

The City of Muskogee today is in serious need of

Two new fire stations and equipment	$1[illegible]
Municipal office building and [illegible] perhaps [illegible] from the county court house	500,000
Water filtration plant, service lines, extensions, new turbine pumps, etc.	250,000
Municipal paving plant	15,000
An appropriation for [illegible]	100,000
[illegible] feet storm sewers [illegible]	7[illegible]
[illegible] feet lateral and [illegible]	[illegible]0,000
[illegible] paving for [illegible]	300,000
[illegible] streets and roads	60,000
[illegible]	[illegible]0,000
[illegible] at Oklahoma Free State Fair...	100,000
Additional park [illegible], tennis courts [illegible]	50,000

But all of this is merely an engineer's and city planner's pipe dream until transportation costs are greatly reduced, [illegible] construction labor is cut in two, bonds worth par and interest with a premium of 1 to 2 per cent, and business—especially the agriculture and oil and coal business and the railroads—can be doing business at a profit they can see and feel.

[illegible] as a whole can carry on, the units of that government must be gaining strength, and the people cannot longer be fattened on national propaganda; the national and state figures are looking larger to the taxpayer every day. They do not resent the municipal and county and school taxes so much, but with franchises and public service and water and transportation contracts always being held [illegible] by the courts, especially the federal courts, we are due for a very still time of watchful and hopeful waiting until the men who pay the taxes start with some slight degree of certainty what the future will be.

JOHN R. MARCH.
Muskogee, Okla. City Engineer.

The Situation at Altoona, Pa.

Our waterworks facilities are reasonably well up to date. [illegible] solved our water [illegible] problem, [illegible] of raising the [illegible] of Lake Altoona for an indefinite number of years. [illegible] will require [illegible], however, can be financed at present out of current revenues.

One sewer improvement should be provided for in the near future by building the main drainage sewer past the water storage reservoirs, which will require about 5 miles of 8-in. and 12-in. sewers, estimated to cost about $6,000. There is much public sentiment in favor of building this sewer, but no provision has yet been made for financing this improvement.

Sewer construction in 1921, when $335,000 was expended, brought our sewerage facilities to the point where no large extensions are needed. Perhaps our greatest need is for reconstruction of old sewers, which should be undertaken in the near future, requiring an expenditure of about $100,000. No steps are being taken at present outside of preliminary investigation work.

Altoona has a large yardage of brick pavements, much of which requires resurfacing. To do so through current expenditures will require the setting aside of $25,000 to $30,000 per annum for this purpose. Our current appropriation is too small to permit us to do more than a small part of the needed construction this year. New paving construction as far as financing arrangements are concerned are limited only by the willingness of property owners to petition for paving improvements, as the cost is assessed against the abutting property. However, paving costs have jumped to such a figure and unemployment has been so general that the property owners have not petitioned for paving in the same volume as in the years preceding 1917. Whether they will do so this year remains to be seen, as only a small amount is on our schedule at this writing.

To expedite construction a general resumption of business seems necessary, as such a large percentage of Altoona people depend directly on the activity of the Pennsylvania Railroad shops and the long period of unemployment is not conducive to the undertaking of much new work, either on assessment or bond issue basis.

H. J. BAUM,
Altoona, Pa. City Engineer.

Waterworks Improvements at Walla Walla.

The city of Walla Walla has kept up a pretty good improvement plan with the exception of last year, in practically all lines of municipal work. This year we intend spending approximately $500,000 on our water works betterments, which includes, additional extensions of the gravity supply pipe lines and about $250,000 for a distributing reservoir. In addition to this the water department spent last year approximately $50,000 for the renewal of a portion of the gravity supply pipe line. With this expenditure the water system will be practically up to date.

A considerable paving program is being formulated, but whether it will be carried out or not, I am unable to say at this time.

The city of Walla Walla is practically all sewered with the exception of some of the outlying districts which are not very thickly populated.

Considerable building construction is being considered, and from the present prospects, I would say that in another month that quite a few contracts will be let.

W. R. REHORN,
Walla Walla, Wash. City Engineer.

Paving Contemplated at Boise City.

Waterworks are privately owned and managed. The city has nothing to do with it except pay the bills.

The entire city is sewered at least so far as being built up is concerned. There are a few outlying districts recently added to the city that are not sewered and will not have these improvements for some time to come, because of the prohibitive cost. Our sewers empty into the river untreated at present below any immediate taking of water for irrigation and some miles above the next ditches.

We need sewer treatment which will be expensive, as it means a pumping plant as well as treatment works. No movement has been started to undertake this improvement. One year ago the main was extended ½ mile to take the outlet below head of irrigation ditches.

We have a program laid out contemplating about 45,000 sq. yd. new pavement and 2,700 sq. yd. alley pavement also 10,766 sq. yd. resurfacing of alley pavements, and approximately 1,500 sq. yd. repairs on asphalt pavement. Possibly there may be more paving done if property owners request it.

C. C. STEVENSON,
Boise City, Idaho. City Engineer.

Better Prices for Bonds Would Bring More Construction.

We are not very much behind in keeping up our general improvements. During the past three years we have laid three miles of asphalt streets, built a new water supply equipped with modern centrifugal, electrical driven pumps, and have a program of three miles more of paving this season.

We hardly know what conditions we will meet with in the bond market; however, if it would be possible for your organization to bring about a more helpful condition from bonding houses, much more work would be undertaken.

Conditions here show that labor and material are not far out of the way, and our only fear is that bonds will not sell as they should.

T. H. ZELL,
City Auditor.

Xenia, O.

St. Joseph Will Vote on $3,400,000 Bond Issue for Public Work.

Until 1916 there was no appreciable "letup" in any of our public improvements, as there had been no increased cost of doing the work. However, in the early part of 1916 prices started to go up, and the effect was very noticeable as soon as the work which was under way had been finished. Since that time, the improvements have not kept pace with the wear and our pavements, particularly have been wearing out faster than we have been renewing them. As prices have fallen, the amount of work has gradually increased. In the matter of sewerage and waterworks, I think that we are just about holding our own at the present time, but in the matter of pavements we are not yet back to where we are "holding our own." I think this is due very largely to the increased use of the truck and a general increase in the volume of vehicles using the streets. There are a great many streets which were built for a much lighter traffic which are being destroyed by this heavy traffic, which would, under the traffic for which they were built, last for a number of years.

This section, like a great many others, is suffering at the present time from the shrinkage of stocks on hand, and also from the limited amount of employment. Merchants have made little or no money, and some of our large wholesale houses, of course, lost money. It is a very difficult matter to convince people who are either out of employment or who are not making money at their business, that they should go ahead with public improvements that must be paid for by them immediately. However, a certain amount of this work must be done to keep our streets passable and maintain the health of the community. It is, therefore, impossible to get back to the stride we had before the war until people have the money to pay for these improvements.

We believe here that a certain class of improvements which we can pay for by bond issues should be done at this time to give employment to a number of our people and to stimulate general conditions. These bonds are retired over a 20-year period, and while we get the advantage of the improvements at the present time, they will be paid for at a time when we believe people generally will be in better condition to make the payment than they are now

The council has passed ordinances providing for a general election on different projects aggregating $3,400,000. These projects include the extension of sewers construction of city hall, museum, soldiers' memorial, construction of municipal light plant, purchase of an asphalt repair plant, and a number of others. This election will be held April 11.

In order to bring about a general resumption of municipal construction, I believe that the cost of doing work must either be reduced or the taxpayers convinced that no lower level will be obtained for some time to come.

W. K. SEITZ.
City Engineer.

St. Joseph, Mo.

Results of Mosquito Control Work in New Jersey.—In an address at the recent convention of the New Jersey Mosquito Extermination Association it was stated that as a result of mosquito control work in the state in the last seven years, malarial cases had been reduced from 771 in 1914 to 83 in 1921 and not less than $1,000,000 had been added thereby to the wealth of the state. Hudson County alone had reduced the pest from 100 per cent in 1914 to less than 5 per cent in 1921 and the economic results could be seen in every direction.

Cost Accounting and Bookkeeping Records for Consulting and Practicing Engineers

Necessity and Advantages of Proper Bookkeeping Systems and Records for Engineers Discussed in Paper Presented at American Association of Engineers' Conference of Practicing Engineers

By ARTHUR L. MULLERGREN

To make a success of the engineering business, business methods must be employed. The prime object of any business is to make a profit. How are the true profits determined in the operation of a business? From the records of the operations. Suppose there were no records kept, yet the owner of the business always managed to have a few dollars left after paying his expenses, which we will say also included his personal living expenses. Was a profit really made in the business? That would depend upon whether or not the owner was gradually consuming his previously accumulated capital unknowingly. His capital may have been money, goods or tools. If he is a practicing engineer thoroughly trained in the science, with little or no money to start, you may say he has no capital. Nevertheless, he has, and the amount depends upon his knowledge and experience. Therefore, if this training and experience is not capitalized and put upon its maximum earning basis, the engineer is losing money.

Accurate Accounts of Operations Essential.—In order to properly determine his true earnings, the engineer must keep an accurate account of his operations in the same manner that any other business keeps a record. There may be a difference in the kind of records, but the fundamental principles will remain the same. Cost accounting in the practice of engineering is as essential as in the industrial line. In order to keep properly accurate cost records of the various projects handled, a proper system of books must be used. The large engineering organizations of today that handle both engineering and construction keep such records, but the independent practicing engineer and the average consulting engineering organization maintain few, if any, records of their operations. Therefore, they are not able to determine whether or not the business is on its maximum earning basis.

System Depends on Organization and Volume of Work.—The proper system to be used for any engineering business will depend upon the kind and size of organization and the volume of work handled. The larger the organization and volume of business, the more elaborate should be the detail of accounts. The records installed should be neither burdensome nor expensive to maintain, but in keeping with the business in hand and so established that the system can be expanded as the organization and business grow. The fundamental system should, therefore, be established with care.

As the average engineer is not very well versed in accounting practices, he should at the start engage a certified or public accountant to establish the system. The accountant should be fully advised as to the character and extent of the business conducted at the time, and the ultimate scope and possible extent. This information will enable the accountant to open a system to fit the present needs and one that can be expanded as the business warrants.

In establishing the system of records the engineer should bear in mind that his activities broaden with time, so that his present activities are not altogether indicative of the future scope and possibilities. I am giving herewith a system that has been in use in our organization for a number of years, and as it seems to fit the needs of the engineer and is capable of expansion, it may be of some benefit to the practicing engineer. The basic records consist of the following:

Cash Book.
Check Record.
Journal
Voucher Record.
General Ledger
Project Record

For a smaller volume of business, all of the above records can be combined under one cover in the loose leaf record systems are used. The loose leaf system is probably the most adaptable for an engineering business and offers the advantage of combining several or all records under one cover where only a small number of vouchers is handled. As the business expands, the records can easily be separated and suitable covers provided for each one.

The Voucher System. The system I am here describing embodies the use of vouchers and the voucher system is recommended. This system enables the making and keeping of an accurate distribution of all expenses and keeps a permanent record of the transaction as well as the internal system. The voucher should be of such form that it can be folded into a convenient size, when the original receipts are attached to same. The face of the voucher should show the payee, the voucher number, number of check by which paid, and the distribution of the charges covered by the invoice. The vouchers should be numbered consecutively and filed in numerical order. They are listed in the voucher record in numerical order, which record also shows the total amount of the voucher and the date when paid.

A separate card index system is used for listing the vouchers by names of the payees so that any voucher can be readily located. The cash book shows the dates of all cash received, the amount, by whom paid, and the date of deposit in the bank. The journal needs no particular explanation, but it is used in adjusting accounts and making correcting entries. The check record provides space for the recording of all checks in numerical order, the date of issuance, check number, payee and account or voucher number to which charged.

The Asset and Liability Accounts. The general ledger consists of the asset and liability accounts. For the average engineering business the asset accounts would consist of the following:

Accounts Receivable
Notes Receivable
[illegible]
Petty Cash
Furniture and Fixtures
[illegible]
Library
Investments

The liability accounts would consist of the following:

Accounts Payable—[illegible]
Accounts Payable—[illegible]
Notes Payable

The remaining accounts would be the capital stock, or present work, surplus, income and expenses.

The Income Account. The income account should be divided into "fees" and "miscellaneous," as it is advisable to keep the moneys received for miscellaneous purposes separate from the fees for professional services. The expense account should be subdivided and the extent of the subdivision will depend largely on the size of the organization. The following classification of expense account will probably serve adequately for a general engineering practice:

Project Expense
General Expense
Office Expense
[illegible]
Office Rent
Telephone and Telegraph
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

The Project Cost Records. The project expense would include all expenses directly chargeable to the various projects being handled, such as the resident engineers' salaries, traveling and hotel expenses for the project, blue printing supplies and time of office principals and assistants actually engaged on the particular project. The project expenses, in other words, represent the total direct expenses incurred for handling the particular project. Each project will have a separate account so that the actual cost of handling the project can be readily determined. The remaining expense accounts are the general expenses and are properly termed the overhead expenses. At the end of each month the overhead expenses should be prorated to the various projects according to the size and importance of the project. The total direct and overhead expenses will, therefore, represent the actual charge to each project, and the difference between this amount and the total fee received will represent the profit on the work. The project expenses can be kept in a separate loose leaf book in alphabetical order and the sum of these project expenses would represent the total project expense as shown in the general ledger.

In order to keep an accurate cost record for each project, all assistants as well as principals should keep an accurate distribution of the time engaged on any particular job. Also, all expenses incurred, such as traveling, hotel, etc., should be filled in the form of an expense account at the end of each month, showing the distribution of the expenses to each job. This expense account and distribution of time can then be readily charged to each project.

The purpose of this discussion is to show the necessity and advantages of proper bookkeeping systems and cost accounting records for engineers and the brief outline of the kind of a system is given merely to show that it is not an expensive nor burdensome matter to maintain proper records. It is firmly believed that if the practicing engineers kept such records in the proper manner and ascertained the true cost for handling particular classes of work, that more adequate fees would be received in a great many cases. The small fees that are received in a great many instances are due to the lack of knowledge of what it really costs to perform the services contracted for. It is, therefore, hoped that the practicing engineers will systematize their business and keep such accounts and endeavor to conduct their business along business lines, and if this is done the engineering profession in general will benefit, as adequate fees will be charged. No one desires to handle any particular class of business at a loss and the only way to determine whether or not he is operating at a loss is to keep an accurate record of cost of his operations.

The Treatment of Carbon Monoxide Poisoning

Carbon monoxide poisoning is one of the most widely distributed and most frequent of industrial accidents, says the U. S. Public Health Service. The gas is without color, odor or taste. It is an ever-present danger about blast and coke furnaces and foundries. It may be found in a building having a leaky furnace or chimney or a gas stove without flue connection, such as a tenement, tailor shop, or boarding house. The exhaust gases of gasoline automobiles contain from 4 to 12 per cent of carbon monoxide, and in closed garages men are not infrequently found dead beside a running motor. A similar danger may arise from gasoline engines in launches. The gas is formed also in stoks-rooms, in gun turrets on battleships, in petroleum refineries, and in the Leblanc soda process in cement and brick plants. In underground work is may appear as the result of shot firing, mine explosions, or mine fires, or in tunnels from automobile exhausts or from coal or oil burning locomotives.

Carbon monoxide exerts its extremely dangerous action on the body by displacing oxygen from its combination with hemoglobin, the coloring matter of the blood which normally absorbs oxygen from the air in the lungs and delivers it to the different tissues of the body.

Oxygen will replace carbon monoxide in combination with hemoglobin whenever the proportion of oxygen in the lungs is overwhelmingly greater. Therefore:

1. Administer oxygen as quickly as possible, and in as pure form as is obtainable, preferably from a cylinder of oxygen through an inhaler mask.
2. Remove patient from atmosphere containing carbon monoxide.
3. If breathing is feeble, at once start artificial respiration by the prone posture method.
4. Keep the victim flat, quiet, and warm.
5. Afterwards give plenty of rest.

Great Industrial Improvement Predicted.—A forecase of great industrial improvement for the month of March was made March 5 by the United States employment service, in connection with its monthly report of employment conditions in the United States. "Reports from 231 of the principal industrial centers, with but few exceptions, show a general improvement in employment conditions," Director Jones of the service announced, "and breathe an enthusiastic spirit of hope and confidence in the future. Weather permitting, March will begin an era of great activity."

Construction Features of Hetch Hetchy Dam

Construction is now well advanced on the Hetch Hetchy dam of the new water supply development of San Francisco.

The dam is to be of the gravity type, arched in plan, with the radius of the up-stream face at the crest 700 ft. The cross-section, at the maximum section is shown in the accompanying drawing. The principal dimensions are as follows:

	Initial	Ultimate
Total length on crest, in feet	[illegible]	900
Height of crest above stream level, in feet	226	[illegible]
Depth from stream level to bed-rock, at toe of dam, maximum, in feet	101	101
Total height of dam, above bed-rock, in feet	327	413
Width at top, in feet	15	25
Width at base, maximum, in feet	[illegible]	310
Volume of masonry, in cu. yd.	[illegible]	600,000

Most of the dam will be of 1:3:6 concrete embedded with large stones. For the concrete against the foundation, the cut-off trench, the up-stream face, and the down-stream face in the spillway section, a 1:2½:5 mixture is to be used to give greater impermeability.

The limiting working stresses in the design were as follows:

	Tons per sq. ft.
Pressure normal to joint, up-stream toe:	
Reservoir empty	[illegible]
Reservoir full	16
Maximum pressure in section, under worst combination of conditions and lasting for comparatively short periods of time	27.5

No tension was permitted in the concrete. On each joint, upward water pressure was considered as acting at the up-stream face with an intensity of two-thirds the total hydrostatic head and diminishing uniformly to zero at the down-stream face. On the foundation joint, an upward pressure of two-thirds the hydrostatic head due to the backwater was also considered.

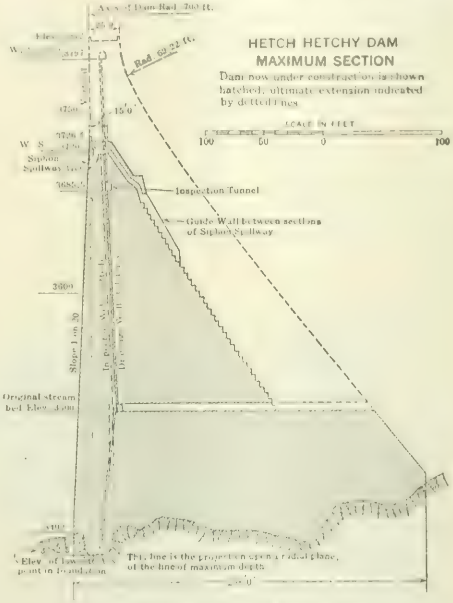
The dam is to be penetrated by a system of inspection tunnels, inspection wells, and drainage wells. The inspection wells will be lined with dense concrete blocks and equipped with ladders. The drainage wells will be in porous concrete blocks and will be 15 in. square.

Radial contraction joints, sealed by bent copper water stops, are provided at intervals of about 100 ft., measured along the up-stream face. Each contraction joint bisects an inspection well. The crest of the dam will be used as a roadway, in both the initial and ultimate developments.

Spillway.—The ultimate dam will have a spillway of the weir type, with a channel to carry the waste water around one end of the dam. A siphon spillway has been adopted for the initial dam, and will be in eighteen sections, staggered in elevation to obviate vacuum effects, with a total length of clear openings of 180 ft. 6 in. Each section will be 8 ft. high at the entrance, tapering to 4 ft. at the crest of the siphon, and will have two air vents, each 12 by 24 in.

Outlet System.—There will be twelve outlet conduits, six of which will be each 5 ft. in diameter, and arranged in pairs at three levels. These will discharge water (in quantities up to 3,000 sec.-ft.) which under certain conditions of river flow is permitted to pass the dam for the use of irrigation districts in the lower reaches of the Tuolumne River. Each of the other six outlets will be 3 ft. 6 in. in diameter in two groups of three, and will discharge the water for the city supply. The smaller outlets will ultimately discharge directly into the aqueduct tunnel to be constructed in connection with the future power development at Early Intake, whereas the water for irrigation may flow directly down the bed of the river.

The discharge in each conduit will be regulated by balanced needle valves with the Larner-Johnson type of control. At the entrance to the conduit there will be a slide gate with hydraulic cylinder operation. A heavy reinforced concrete


Axis of Dam Rad. 700 ft.
Rad. 69.22 ft.
HETCH HETCHY DAM
MAXIMUM SECTION
Dam now under construction is shown hatched, ultimate extension indicated by dotted lines
SCALE IN FEET
100
50
0
100
15'0"
3726
3685.5
Siphon Spillway
Inspection Tunnel
Guide Wall between sections of Siphon Spillway
3600
Slope 1 on 20
Original stream bed Elev.
Elev. of lowest point in foundation
This line is the projection upon a radial plane, of the line of maximum depth

Maximum Section of Hetch Hetchy Dam

Dam Now Under Construction Is Shown Hatched, Ultimate Extension Indicated by Dotted Lines

General View of Dam Site Looking Down Stream, Taken May 15, 1921. Chutes Are in Place Ready for Depositing Concrete in Lowest Portion of Foundation. The Large Pieces of Rock Piled in the Foundation Will Be Embedded in the Concrete.

[illegible] must be lowered through a [illegible] to the [illegible] of the outlet elevators to close the opening on the up-stream side of the [illegible] then providing [illegible] for an [illegible] of [illegible].

Stream Control During Construction.—The maximum recorded flood flow of the Tuolumne River at the dam site, during the [illegible] years for which records are available, was [illegible] sec.-ft., and the stream-control works were planned for approximately that quantity of water.

The river is by-passed around the dam site through a tunnel [illegible] ft. wide, [illegible] ft. high and [illegible] ft. long. The lower [illegible] of these 3 ft. 6 in. outlet conduits will be [illegible] later in the [illegible].

The diversion dam is a rock-filled crib [illegible] ft. long of 12 by 12 in. timbers. The up-stream face is sheathed with a double layer of 2 in. plank with a layer of tarred burlap between. A maximum head of [illegible] ft. over the top of the timber was provided to dispose of any flood water.

A concrete dam was built just up-stream from the lower portal of the diversion tunnel, to prevent water discharged through the tunnel from backing up into the dam site. This dam was founded on boulders and coarse gravel and is 51 ft. long on top. Its foundation was grouted to secure water tightness.

Contract Prices.—The contract for the construction of the initial development of the Hetch Hetchy dam was awarded on Aug. 1, 1919, to the Utah Construction Co., at a total estimated price of $5,447,972. The principal items were:

Excavation in dam foundation.	Approximate quantities cu. yd.	Unit prices Below original stream bed	Unit prices Above original stream bed
Gravel and loose rock	[illegible]	[illegible]	$1.50
Solid rock	[illegible]	[illegible]	3.00
Cyclopean masonry 1:3:6 concrete with at least [illegible] of plums	[illegible]	[illegible]	17.00
Mass concrete, 1:2½:5	[illegible]	[illegible]	14.30

Excavation for Foundations.—A steam shovel was used for the greater part of the excavation in the dam site, loading directly into dump cars. When the space became too cramped to permit steam shovel operation, the final 20,000 yd. was loaded into the skips by hand. The skips were emptied into trains running on trestles along the north and south walls of the gorge.

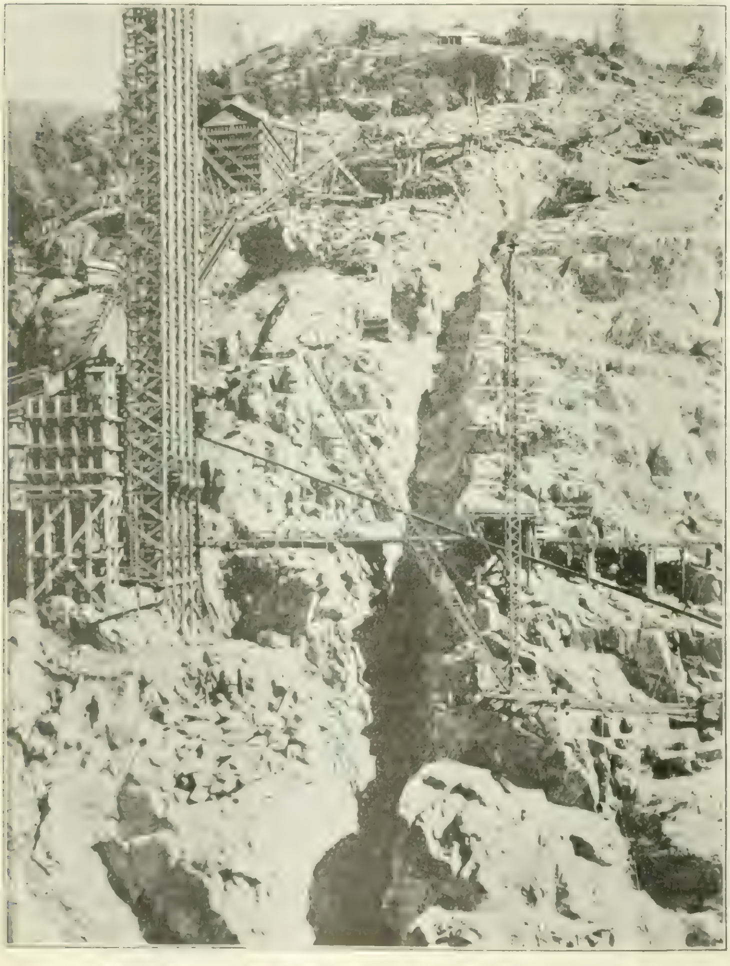
Excavation on the sidewalls and in the cutoff trench above the stream bed level was carried on by drilling with jackhammers and shooting and barring down the material to the river bed, where it was loaded into trains of narrow gauge 4 yd. side-dump cars by a Marion No. 36 steam shovel on crawler treads. The trains were hauled by 18-ton saddle-tank locomotives to a waste bank near the crusher plant and the excavated material was dumped there, where it can be readily re-excavated to be screened and crushed for concrete aggregation.

On reaching the river bed level the steam shovel was used in excavating the foundation pit for a depth of 65 ft. to elevation 3,435. In the lower part of the steam shovel excavation, the trains operated on a very steep incline, with a maximum grade of 20 per cent. The trains were worked on a counterbalance system, the empty train entering the pit helping the loaded train up the steep grade.

The total excavation for foundations was 165,000 cu. yd., of which 100,000 cu. yd. was solid rock. The trains dumped the material on the floor of the valley and much of the dumped rock will be used for concrete aggregate. Large rock fragments and boulders were placed by derricks on convenient corners and ledges for storage until required for plumbs in the cyclopean masonry. The lowest point in the foundation is 113 ft. below the original stream bed.

Nearly all the surface rock in the foundation above the stream level was removed, leaving a newly broken granite surface to receive the concrete, but below that level, where the rock had not been exposed to weathering, the trimming covers a much smaller proportion of the whole surface. The underlying formation is very tight. The foundation below the former steam level is being prepared to receive the concrete, largely by sand blasting which removes scale and soft pits satisfactorily and roughens the polished surfaces. Loose sand and dust are removed by washing and brushing with wire brushes.

Excavation to bed-rock was completed in August, 1921, and immediately afterward the pouring of the concrete was com-



South Abutment and Concrete Plant: Note the Stepped Surface.

menced. It is the intention to pour nearly 400,000 cu. yd. of concrete in 16 months.

Construction Plant and Heavy Equipment.—To handle the material from the deep excavation, and later to place plum rock in the cyclopean masonry, one steel derrick with 100 ft. boom, one with 110 ft. boom, one wooden [illegible] derrick with 70 ft. boom and one with 60 ft. boom are in place. These so overlap as to cover all points in the lower portion of the dam. In connection with the derricks a new railroad line was built on the south abutment at elevation 3,540, connecting with the valley railroad system by crossing of the diversion dam, and a railroad track has been placed at the same elevation on the north abutment. Dumping platforms were arranged on these railroads, enabling the derricks to unload 3-yard skips directly into the dump cars. When concrete work is under way the derricks will handle loaded skips of plum rock from the flat cars to the cyclopean masonry without interfering with the pouring operation

A 15-ton Lidgerwood cableway with a span of 903 ft. of 2¼ in. cable, supported on towers 528 ft. above the bottom of the foundation pit, and having a speed of 900 ft. per minute, has been erected. The cableway is so placed as to permit handling the 5-ft. balanced valves on the face of the dam and the three-foot valves down the shaft to the diversion tunnel.

Machinery, industrial locomotives and other heavy equipment, lumber and timbers, etc., are handled by this cableway from cars standing on the track of the Hetch Hetchy R. R. to the narrow-gauge cars of the contractor's industrial railroad on the valley floor level. The drop from one track to the other is over 300 feet.

Employees quartered at the main camp are lowered to and raised from the work in a skip suspended from the cableway. It requires but four minutes time to transport 55 men from the foundation pit to the camp level.

A narrow-gauge valley railroad has been extended across the gravel and boulder deposit at the foot of Wapama Falls. This railroad was built to haul the excavated material from the dam foundation to the dump in the valley, and to bring sand and rock from natural deposits and from the dump and quarries to the crusher plant for washing, screening and crushing, and to haul the crushed rock and clean sand to the concrete mixing plant at the dam.

Rock Crushing Plant.—A rock crushing plant to produce aggregate for concrete has been erected on the valley floor. The material, ranging from sand up to boulders and rock fragments about 1 cu. ft. in volume, is brought to the plant in trains of 4-yd. dump cars. It is passed over a grizzly with bars spaced six inches apart. The rock which does not fall through the grizzly is crushed by a 26 in. by 42 in. primary jaw crusher.

From this crusher a 30-in. belt conveyor carries the crusher-run rock and the material that passes through the grizzly to a ¼ in. mesh revolving screen. The fine material or sand passing through this screen goes to a log washer, and the coarser material is run through a 2½ in. revolving screen, the rejects continuing to a No. 6 McCully gyratory crusher and a No. 49 gearless, belt driven Kennedy-Van Saun crusher, set for producing 2-in. rock. The re-crushed rock is carried to a revolving ¼ in. manganese steel screen into which jets of water under high pressure are sprayed, separating all crusher dust and diverting it to the sand washer.

After the final crushing of the rock and washing of the sand, these materials are elevated on belt conveyors to a trestle 38 ft. high and discharged into storage piles, one for rock and one for sand, under which are two trap tunnels with mining dump doors, spaced 14 ft. on centers. This storage has a capacity of 8,000 cu. yd. of sand and crushed rock. From the storage piles 4-yd. side dump cars are loaded with aggregates by gravity, the spacing of the trap doors permitting all the cars of a train to be loaded without moving the train.

Concreting Plant.—A concrete mixing plant with a capacity of 100 cu. yd. per hour has been installed near the up-stream face of the dam on the south abutment, at elevation 3,540, 158 feet above the lowest point in the foundation pit and 187 ft. below the crest of the dam.

This plant consists of two 2-yard motor-driven Ransome mixers, with a charging bin of 300 cu. yd. capacity elevated above the mixers. The sand and rock brought in the dinky trains from the crusher plant are dumped into small receiving bins and elevated by motor-driven belt conveyors to the charging bin Immediately below the charging bin are measuring bins, with a fixed choke feed and inlet gates operated by hydraulic cylinders. The gates from the measuring bins are also operated by hydraulic cylinders, the mixer man manipulating a 3-way valve to move both gates. Adjacent to the receiving hoppers of the mixers are the cement measuring bins, which are filled from the weigher house, 180 ft. above,, through two 8 in. riveted steel pipes. Water for the mixers is to be pumped from the river into a 10,000 gal. tank on the adjacent hillside and the quantity for each charge measured in a steel drum mounted on the mixer.

The spouting system is used for placing concrete. A four compartment elevating tower, 16 ft. by 27 ft. in horizontal dimensions, and 150 ft. high, has been built of Oregon pine timber. Each compartment is equipped with a self-dumping 1-yd. steel skip. The skips are operated independently by single drum hoists driven by 75 h.p. motors and are capable of a speed of 300 ft. per minute. The tower is designed to have an ultimate height of 340 ft. It is built up of four 10 in. by 12 in. and four 10 in. by 10 in. timbers, thoroughly sway braced, and guyed with ¾ in. cables at every 40 ft. of its height. The concrete will be distributed from the tower through two lines of 15-in. Insley chutes, with 50 ft. counter-balance sections.

Cement Storage and Transportation.—All cement, except the relatively small quantity required for concrete blocks and miscellaneous small jobs, is delivered to the job in bulk. The box cars in which the cement is brought to the dam site over the Hetch Hetchy R. R. are emptied by means of an unloader consisting of a small motor driven winch which drags a flat board scraper. The cement falls from the car doorway into a hopper, from which a 12 in. screw conveyor takes it to a storage bin 150 ft. away, which bin is 60 ft. long, 32 ft. wide and 34 ft. deep, built with a V-shaped bottom, making the entire 13,000 bbl. capacity (about 60 carloads) live storage. From the bin a 12 in. screw conveyor 120 ft. in length will carry the cement to a weigher house. This conveyor runs through a 4 ft. by 6 ft. tunnel beneath the storage bin. Slide trap doors are arranged along the sides of the tunnel to release the cement from the bin

The weigher house is equipped with two 1,200 lb. capacity scales with automatic feed and cutoff arrangements. Electrically operated signals, consisting of flash lights and horn sounders, and an independent telephone line, are being installed to provide means of communication between the weigher house and the mixer house 180 ft. below. Two 8-in. steel pipes on a 1-to-1 slope will carry the cement from the weigher house to the cement measuring bins near the mixers. The Hetch Hetchy Water Supply Department is being carried out under the direction of an engineering staff, of which M. M. O'Shaughnessy, city engineer of San Francisco, Calif., is chief engineer, and N. A. Eckert is project engineer. The foregoing article was prepared from a paper, "Construction Progress of Hetch Hetchy Water Supply," by Mr. O'Shaughnessy, in the February Proceedings of the American Society of Civil Engineers, and from the annual report of the Bureau of Engineering of the Department of Public Works of the city and county of San Francisco.

Collecting Water Samples by Automobile

The New Jersey State Laboratory of Hygiene, a branch of the State Department of Public Health, according to the 1921 report of the Department has obtained exceptionally successful results by collecting water samples by automobile. Samples were collected from all public supplies and complete sanitary analyses made. As the Ford automobile used for the collection purposes had been run over 30,000 miles before it was used for water collection work, the cost of collection per sample was materially higher than it would have been if a serviceable car had been available, as repair charges on this car were abnormally high. Some of the advantages of the collection system instituted are: Breakage of containers abolished, delay between the time of collection and receipt of samples at laboratory eliminated, bacteriological samples suitably iced and brought to the laboratory in proper condition for reliable analyses, number of samples and time of their receipt controlled so as not to conflict with other work. Using this car for the collection of water samples four days of the week, it was possible to loan it to the Food and Drug Bureau for cannery and creamery inspections, thereby utilizing the last two days of the week.

A Reply to Edison's Questionnaire on the Issuance of Money Based on Property

By HALBERT P. GILLETTE

[illegible] Engineering and Contracting

A [illegible] Thomas A. Edison [illegible] the [illegible] of the [illegible] upon the [illegible] wealth of the [illegible] money based on the gold standard. The [illegible] of his questionnaire [illegible] as follows:

1. [illegible] of the [illegible]

2. [illegible] the United States [illegible] Federal Reserve [illegible]

3. Would the money thus issued [illegible] the gov[illegible] [illegible] that it is very [illegible] would [illegible]

4. The [illegible] of Andrew D. White [illegible] "Fiat Money Inflation in France" is used as a terrible example. Is it not true that there are two sides to this question of which White gives [illegible] France just before the issue of assignats was hopelessly bankrupt and would have been worse off without assignats [illegible] of assignats, which [illegible] France to become one of the richest nations. [illegible] worthless [illegible] and [illegible] that money [illegible] within a country should have [illegible] twice the value of [illegible]

5. [illegible] has issued and is now issuing enormous quantities of fiat money. [illegible] Yet all her people are working [illegible] fiat money. [illegible] and we have depression [illegible] Point out why this [illegible]

1. The Demonetization of Gold. If gold were demonetized its value would be enormously reduced, at least temporarily. Any attempt to estimate the approximate reduction in value would be a mere guess. Prior to the world war the annual production of gold was about $450,000,000, of which about 20 per cent was produced in the United States. The United States used about half the gold that it produced for jewelry and other manufacturing purposes. The rest of the world used a somewhat smaller percentage in the arts, for the United States imported annually about $65,000,000 of gold, or nearly 20 per cent of all the gold produced annually outside of the United States. It seems safe to say, therefore, that the value of an ounce of gold would decline more than 50 per cent immediately following demonetization.

2. Money System Based on Warehoused Commodities. If the government were to issue paper money to the extent of 50 per cent of the value of warehoused commodities, based on their average prices over a period of 25 years, the paper money so issued would be "sound" in that it would have commodities back of it, but it would probably be very unstable in its purchasing power, and to that extent unsound, in that its quantity would be variable. In our present Federal Reserve Banking system we have essentially just such a monetary system as the one Mr. Edison suggests; for by the rediscounting of commercial paper the member banks secure Federal Reserve notes (or paper money), and the commercial paper is itself based on commodities and other property. It is true that Mr. Edison suggests one element of departure from the Federal Reserve system, namely, the issuance of paper money based on average prices of commodities over a 25-year period. But this would be only one factor in determining the quantity of paper money thus put into circulation. The other factor would be the total quantity of commodities put into the government warehouses. As the volume of warehoused commodities rose or fell, so would the quantity of paper money rise or fall; and, as will be outlined later, the price levels would similarly tend to rise or fall. This fluctuation in the volume of money would constitute the main objection to the system that Mr. Edison proposes, just as it now constitutes the main objection to our Federal Reserve system. If price levels tend to move in harmony with money levels, as they unquestionably do, a thoroughly satisfactory money can never be based on commodities whose volume fluctuates materially.

Commodity Price and Wage Levels. The quantity theory of money as affecting price levels, as usually presented, has been imperfect; nevertheless, it was approximately correct. In the April 20, 1920, and the Aug. 3, 1921, issues of Engineering and Contracting I have endeavored to produce scientifically correct theories on commodity price and on wage levels. To do so I have quantified each of the main factors that affects price and wage levels, for in no other way can any such theory be put to a crucial test. The wage level formula, which is the simpler of the two, has stood the test of agreement with the facts in a manner that is certainly not to be ascribed to chance. I show in the article in the Aug. 3, 1921, issue that the wage level in America has for 80 years moved in almost exact accord with the number of dollars of money in circulation per capita. There is a second factor, namely, velocity of money circulation or rate of money turnover, which increases in boom times and decreases in times of depression, but rarely rises or falls more than 20 per cent from a mean rate. It is the presence of this factor that has been ignored by all critics of the theory that prices tend to rise or fall with the increase or decrease in the quantity of money. These critics have only recently triumphantly pointed out that while the quantity of our money was stationary, prices and wages were falling, as if that were proof conclusive that the quantity of money does not affect prices. Such an argument is like claiming that there is no downward current in a river because a steamer is moving upward, or that gravitation is not pulling because a balloon is rising.

Factors that Affect Wage Levels.—There are three great factors—and they overshadow all others—that affect wage levels, namely, (1) the quantity of money in circulation, (2) the number of people, and (3) the rate of money turnover. The first two factors form a ratio, by dividing the first by the second, called per capita money. Since the third factor oscillates about an average or mean from which it departs but little (20 per cent at most), and then only for a short time, we can call it approximately constant if we seek to test the wage level formula over a long period of time. The following table, reprinted from the Aug. 3, 1921, issue of Engineering and Contracting, gives such a test, from the year 1840 to 1920:

WAGE LEVELS, ACTUAL AND CALCULATED, BY AN APPROXIMATE FORMULA

	Wage level			Wage level	
Year.	Actual.	Calculated.	Year.	Actual.	Calculated.
1840	37	36	1885	71	77
1850	41	40	1890	76	76
1855	44	51	1895	74	77
1860	45	46	1900	76	89
1865	68	68	1905	86	103
1870	76	58	1910	94	114
1875	72	57	1915	103	120
1880	65	65	1920	220	191

Note: The formula used was $W = 10/3 \times M P$, or the wage level is ten-thirds of the per capita money. This formula is only approximately correct, for it assumes a constant velocity of circulation of money. See Table V for an application of the more precise wage level formula.

In 1840 the formula checks with the actual wage level within 3 per cent, and in 1920 within 15 per cent. The agreements for the intermediate years never exceeding 25 per cent, and usually hovering around 6 or 7 per cent. Bearing in mind that these failures to check more closely are due to assuming that the rate of money turnover is a constant, and bearing in mind that the wage level rose from 37 in the year 1840 to 220 in the year 1920 (an increase of nearly 500 per cent), I think it will be agreed that the formula agrees as closely with the facts as the average formula used by engineers in designing structures—in short, that it is correct enough for all practical purposes.

The price level formula (given in the April 7, 1920 issue) differs from the wage level formula only in one respect. It introduces a fourth factor that I have called per capita efficiency of production. As this factor rises, prices tend to fall; as it falls, prices tend to rise. Every economist will agree that the efficiency of production factors acts as I have stated; but prior to the publication of this article no economist, so far as I know, had ever given even an approximate quantitative value to the efficiency factor for any nation over a long term of years. The article explains exactly how this efficiency factor was [illegible] the past 60 years in America.

In this connection it may be of interest to state that the gathering of the data used in these calculations, the analyses of the data, the study of available treatises relating to price and wage levels, the derivation of the price and wage level formulas, and the final checking of the formulas against the facts, consumed an amount of time equivalent to that of one engineer working eight hours a day for a year. I mention this because there is a prevalent opinion—particularly among non-scientific men—that any bright man (especially a banker whose business it is to deal in money) is competent to express an opinion upon the causes of variations in price and wage levels and the like. Mr. Edison, as a scientist, knows that, however simple a new physical problem may look on its face, the probability is that its correct solution will consume far more time than a non-scientific man would expect. The mere fact that a man has dealt in corn or has raised corn all his business lifetime, does not constitute the sort of experience that enables him to explain the fluctuations of the corn crops, or to foresee the changes in corn prices very far in advance. Similarly it can be seen that unless a banker has gone outside his routine work, and has spent a great deal of time investigating price and wage levels, he is not likely to be able to give even an approximately correct statement of the factors involved, to say nothing of being able to quantify each of the factors.

3. In answering the second question I have answered the third.

4. **The Fiat Money Question.**—The questionnaire asks whether there are not two sides to the fiat money question. Did not fiat money help France when she issued the assignats? Did not fiat money help our government during our revolution? The word "fiat" is usually intended to convey the idea that there is no property back of the money, and this coincidently conveys the impression that "fiat" money is "intrinsically valueless."

The fact is that as long as governments have the power of taxation, they have a means of putting all the taxable property of their citizens "back of" any fiat money. The real question, then, is not what is "back of" the money, but how much money is issued. The government of France virtually repudiated its debts to its citizens by the issue of great quantities of assignats. That may have been good for the politicians, but how about the creditors who had loaned money having a high purchasing power, and were paid in money having almost no purchasing power.

The monarchs of England played that same trick even before there was paper money. The original pound sterling was a troy pound of silver. But starting about the middle of the fourteenth century, one king after another reduced the amount of silver in a pound sterling until 250 years later there was only a third of a pound silver in a pound sterling. A study of Rogers' "History of Agriculture and Prices in England, 1259 to 1793," shows that as fast as the weight of the pound sterling decreased, wage and price levels rose.

Although the English monarchs thus were able to cheat their creditors, the only other evil (and that was bad enough) was the successive periods of disturbance of wage and price levels, with their coincident labor troubles. I should not be surprised if an economic historian could show that the major changes in the weight of the pound sterling were provocative of more economic troubles than were the wars waged by the kings.

The government of France may have saved itself from bankruptcy by bankrupting many of its creditors through the issuance of assignats. Perhaps this was not an unimxed evil. But the evil might have been greatly reduced and perhaps eliminated had France never embarked upon the sea of monetary inflation. I have yet to see evidence that France would have been bankrupted had she not adopted that course.

The "fiat" money of our revolution was essentially a promise to pay if the revolution succeeded—a note bearing no interest and redeemable if success by arms was attained. It was taken by the American people because of patriotism. They virtually donated their goods and services to the cause of freedom, and were willing to lose both, if need be, in the hope of securing freedom. I doubt not that what was thus seemingly "accomplished" by the issuance of fiat money could have been accomplished without it; but whether it could or not, the problem that faces America and the world today is a different one from that that faced Washington. Our problem is to stabilize prices. Theirs was to "get by."

5. **The Situation in Germany.** The questionnaire compares alleged German industrial success in spite of fiat money with American depression in the absence of fiat money, and you ask an explanation. To begin with, the evidence that the German people, as a whole, are profitably employed is not to be found in the facts. What do such strikes as those of the entire railway force of Germany mean? What do her meager importations of copper, cotton, wool, etc., signify? Many of her workers are employed—perhaps feverishly employed, but so are the mules behind the driver. Let us ask what the mules get for their daily work, rather than how hard they are working. The continuous labor disturbances in Germany seem to me to answer that question pretty convincingly. I have no sympathy with the German government now or as it was under the kaiser; but I can not sympathize either with the efforts of some of the former allies particularly France—to make the German people pay the entire cost of the war in a relatively short period of time. In the effort to make some foreign payment of reparations and in the desire to evade all domestic payments of war debts, the German government has issued huge quantities of paper money. For reasons above given, this, in effect, serves to repudiate the bonds issued by Germany to her citizens. By printing paper money very rapidly, its value is made to decline rapidly, but there are always a large number of people who fail to realize at first how rapidly the value of the money is falling, and they will part with their goods or services readily even at prices that will soon prove to have been too low. This is particularly true of the manually working classes who can be induced to work for less money wages than they should be receiving on a rising market. Hence many employers have been finding it profitable to keep a great many workers busy in Germany during the rising price market. But we should not be deceived either by the fact that many Germans are busy. The employment cycle has been on its upward swing over there; and is about due for its downward swing.

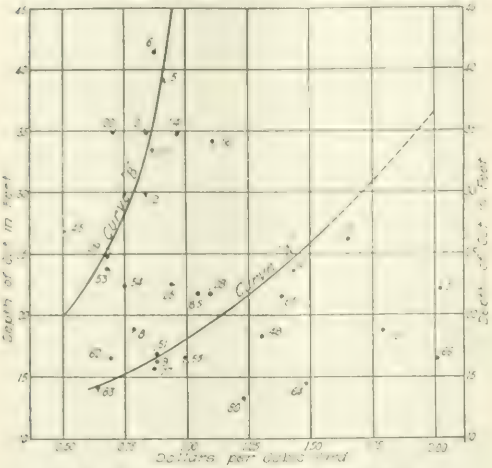
It is merely necessary to look across the German border to Russia to see the sequel to inordinate inflation of currency. There you have a currency so depreciated because of its immense volume that everyone but the political employe avoids it and prefers to keep his goods. The continued issuance of that paper money has been, I believe, the greatest single factor in bringing Russia to its present state of supreme idleness and starvation. The same result will occur in Germany if the quantity of paper money continues to increase rapidly.

Mr. Edison contrasts German employment with American employment, but where are there any reliable statistics as to the percentage of Germans employed? We know within narrow limits the extent of unemployment in America. Mr. Edison is probably approximately correct in saying that 4,000,000 American workers are idle; but this is less than 10 per cent of all Americans classed by the census as engaged in gainful occupations. It has been said that even in normal times the average of unemployed workers exceeds 1,500,000, or about 4 per cent of the total workers of all classes. Surely an abnormal unemployment that reaches only 6 per cent is bad, but yet a long way from disastrous. As against this definite knowledge of labor employment in America, we have only indefinite statements respecting England and Europe. And even if we had definite data that showed less unemployment in Germany than here, the data would argue nothing in favor of fiat money unless, first, the percentage of unemployment remained low for a long time in fiat money Germany, and, second, the purchasing power of the average family in Germany exceeded that in Germany.

In this connection it is interesting to note that the buying power of the average day's wages, both in America and in England, is now about five times what it was a century ago. This remarkable achievement is unquestionably attributable mainly to scientists, inventors and engineers.

Cost of Sewer Construction at Louisville, Ky.

During the construction of sewers in Louisville, Ky., aggregating a cost of about $4,000,000 careful records of the actual cost of the work of the contractors were kept by the Sewerage Commission of 1906, which had charge of the improvement for the city. This work was done principally in the years 1908 to 1911 inclusive. Some interesting data on this costly work are given in a recently issued report of the Commissioners of Sewerage of Louisville. This new commission, of which J. B. F. Breed is chief engineer, and Metcalf & Eddy, consulting engineers, was appointed in 1921 to make a study and report upon a plan for a comprehensive system of sewers for the city. The report has the following to say regarding the 1908-11 data:



Cost to Contractor excluding Cost of Cleaning up, General Expense and Liquidated Damages. Figures refer to number of contract.

Fig. 1—Actual Cost to Contractor of Machine Work Earth Excavation.

How the Costs Were Obtained.—In some cases the contractors kindly permitted the commission's engineers to examine their accounts and make excerpts of actual costs to the contractors. Data relating to the different items were collected by the inspectors on the several contracts, who kept records of all materials such as cement, steel, brick, sand and gravel, of tools and of all machinery and other equipment used, and their costs were ascertained. In estimating the cost of the work the probable expense to the contractor on account of the plant was reached by assuming the rental to be from 20 per cent to 60 per cent per annum of the original cost, depending on the nature of the machinery and the duration of the work. The full cost of small tools and supplies was generally considered a part of the cost of the work, except in the case of small contracts, when it was assumed that the tools and supplies had considerable value after the contract had been completed. Accurate account was kept of the number of hours spent by the entire construction force, including the superintendent, foremen and mechanics as well as the laborers, and the time spent by them upon the different classes of work. In addition to these expenses there was allowed the actual cost of general expenses such as that of surety bond and liability insurance.

The records of the actual cost for all contracts are not to be had at this time. There are available, however, records for 79 contracts representing all classes of work. These records have been analyzed with respect to the three most important items—earth excavation, rock excavation and plain and reinforced concrete.

Earth Excavation, 1908-1911.—The earth excavation was divided into two general classes: first, that done largely by hand, although in cases of some deep trenches this class includes excavation made with the aid of bucket machines, such as the Carson trench machine; second, that done almost entirely by machines, such as steam shovels, clam shell and orange peel bucket excavators, and cableways with bucket excavators, and including that done by slip and wheel scrapers. For each of these classes the cost per cubic yard for each contract has been plotted as abscissae, and the average depth of trench as ordinates. Although these points show a wide variation in the cost of excavation an estimate has been made of the reasonable average costs, taking into account the conditions affecting each contract. The estimated costs to the contractor are shown by the curves on Figs. 1 and 2. In Fig. 1 curve "A" shows the approximate relation between depth of cut and cost of machine excavation for sewers ranging from about 4 ft. to 8 ft. in diameter. Curve "B" shows similar data for sewers 10 ft. or more in diameter. Fig. 2 shows the unit costs for hand work. The estimates of unit cost of excavation are based on an assumed width of trench 1 ft. greater than the outside width of masonry.

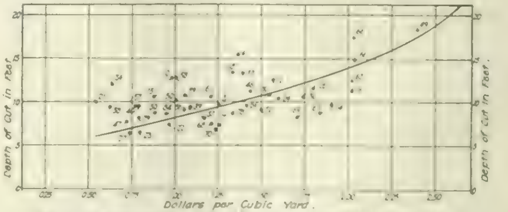
Rock Excavation, 1908-1911.—Estimates of the actual cost to the contractor of rock excavation are available for 26 contracts. The cost varies considerably, being as low as 79 ct. per cubic yard in one case and as high as $8.22 per cubic yard, omitting one contract which included 22 cu. yd. of rock requiring coffer-dam construction and pumping in which the cost was $14.71 per cubic yard. In determining the mean cost to the contractor, the total number of yards estimated on the 26 contracts has been compared with the total cost of rock excavation. The unit cost, exclusive of general expense and overhead, was $3.23 per cubic yard.

Concrete, 1908-1911.—The estimates for concrete have been divided into two classes, plain and reinforced. To the estimated cost of concrete in which reinforcing steel was used, the cost of steel has been added. The costs to the contractor per cubic yard have been plotted as abscissae and the average number of cubic yards per linear foot, as ordinates. These points when plotted indicate that there is a general relation between the unit cost and the quantity per linear foot, and reasonable curves are shown on Figs. 3 and 4 to represent the average cost. The estimates for concrete are based on the amount actually required. In many cases, however, the contractor put in considerable more than this for various reasons.

Data for the foregoing estimates were obtained from the cost records, from the descriptions of the different contracts, and tables given in the 1910 and 1913 reports of the Sewerage Commission of 1906, and from Table 34 of American Sewerage Practice, Volume II.

In drawing the curves to represent average costs consideration has been given to the special conditions of each contract, such as pavement, foundation and ground water difficulties, special work, such as tunneling, and to the proportions of work done by hand and machine where both methods were used on a single contract.

General Expenses, 1908-1911.—In addition to the cost of earth excavation, rock excavation and concrete, there are other items which enter into the cost, such as general expenses, in some cases including salaries of firm members, interest on bond, liability insurance, cleaning up and liquidated damages where such were paid by the contractor.

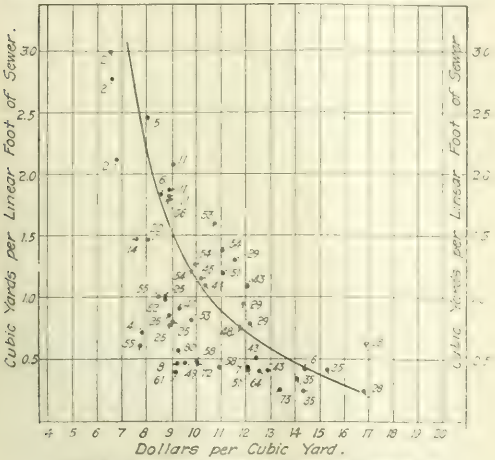


Cost to Contractor excluding Cost of Cleaning up, General Expense and Liquidated Damages. Figures refer to number of Contract.

Fig. 2.—Actual Cost to Contractor of Hand Work Earth Excavation.

Data are available for determining the amount of general expense, liquidated damages and the cost of cleaning up for 79 contracts carried out under the Sewerage Commission of 1906. It was found that the total sum of these items for all contracts amounted to 15.6 per cent of the total actual cost to the contractor, of all other items. In determining the gross cost to the contractor of the different items, an allowance of 15 per cent has been made to cover general expense, liquidated damages and cleaning up.

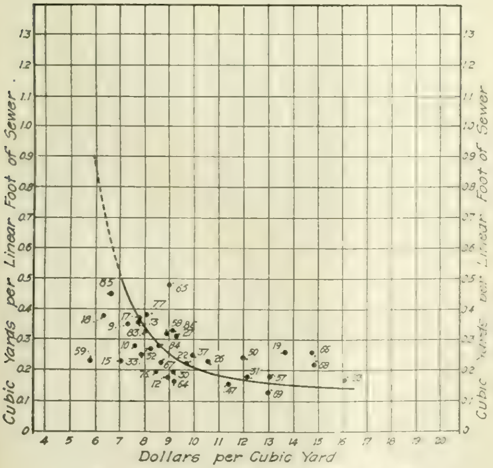
It is recognized that there are frequently other costs of more or less intangible nature, such as home office expense and other expenses which could not be readily ascertained by the inspectors and perhaps were overlooked. To cover such items, which have been classified as home office expense and omissions, an allowance of 5 per cent has been made. Thus it is estimated that the gross cost to the contractor is equal to the actual cost as shown by the engineers' final cost estimate plus 20 per cent.



Cost to Contractor excluding Cost of Cleaning up, General Expense and Liquidated Damages
Figures refer to number of contract.

Fig. 3.—Actual Cost to Contractor of Plain Concrete Sewers.

Contractor's Profit.—After compiling the cost to the contractor as above outlined, an allowance equivalent to 10 per cent of said cost has been added for contractor's profit. This gives the estimated fair cost which the Sewerage Commission of 1906 should have paid. It varies radically from the actual cost to the commission, which, of course, was based upon the contractor's original tender which was sufficient to yield him a greater percentage profit in some cases and in others did not cover his actual cost.



Cost to Contractor excluding Cost of Cleaning up, General Expense and Liquidated Damages.
Figures refer to number of contract

Fig. 4.—Actual Cost to Contractor of Reinforced Concrete Sewers Including Steel.

Unit Prices, 1908-1911.—In order to arrive at a fair estimate of the cost of future work it is necessary to determine with a fair degree of accuracy the unit prices for labor and materials in force during the period of construction under the Sewerage Commission of 1906 and to estimate fair prices for the period of 1922 to 1924. In the 1912 report of the Sewerage Commission, page 4[illegible], is the following statement:

> When the first bids were made [illegible] relatively low, the minimum [illegible] of labor in 190[illegible], and has been [illegible] a decided tendency toward an increase [illegible] it is doubtful if any material [illegible] in the last three years [illegible] been many cases where the labor [illegible]

The length of day referred to was ten hours.

The estimated average unit prices in effect during the period 1908-1911 are as follows:

Item	Price
Common labor	$[illegible] per 10-hour day
Concrete gravel	[illegible]
Sand	[illegible]
Cement	[illegible] per bbl.
Steel reinforcing	[illegible]

These prices are for materials delivered at the site of the work.

Inducing a City to Undertake Improvements

How an engineer directed a successful campaign for rehabilitating the water system of a small municipality is told by R. E. McDonnell of Burns & McDonnell Engineering Co. in a recent issue of the Professional Engineer, from which we quote the following:

In the campaign for the rehabilitation of the water system of Parsons, Kan., preliminary plans, maps, estimates and summaries of the report were prepared on a large scale for use in window displays. About 75 stereopticon slides were made and used at mass meetings and before civic organizations. Municipal band concerts were held outdoors and following the concerts all features of the project were explained—cost estimates, operating expenses, depreciation allowance, bond sinking fund, revenues and rates, with net income, were shown through graphical diagrams. All engineering features were so clearly explained that a prominent attorney, commenting on the project said: "The engineering is shorn of its technical features and we are now all engineers and see the soundness of the whole project."

The Parsons Sun expressed a willingness to publish a series of waterworks articles, which were prepared by the engineers. These articles were run daily, many of them being illustrated by views showing both the present conditions of the waterworks system and the proposed improvements. Over fifty of these articles were prepared and used. They were written, not as a technical journal would use them, but as newsy, interesting items. To test their power to interest readers, an interruption was intentionally made which caused many 'phone calls of inquiry and request for the articles to continue. Some knowledge of the fifty articles may be gained by quoting some of the titles: "Why the Women of Parsons Want Pure, Soft Water," "How Good Health Can Be Purchased," "What Happens When a Water Famine Occurs," "The Cost of a Typhoid Epidemic."

A feature of the improvement was a modern water purification system to displace a very inadequate and antiquated system. Comparative figures were given showing the saving in cost of operating a modern plant, thus showing the voters that they were daily losing money by operating an inefficient plant, besides giving the city an unsafe water to drink. Former bad fires were illustrated, with tables of annual fire losses, showing the fire loss per capita far above that of other cities. Insurance rates were shown to be exorbitant because of the present inadequate protection. Fire losses due entirely to poor pressure were shown to exceed the total bond issue asked.

A portion of the improvements consisted of replacing a large amount of small steel and wrought iron pipe, also replacing a flow line of spiral riveted steel and vitrified pipe. The leakage figures were given, showing a loss of over half the water pumped. Exhibits of this worn-out pipe were placed at prominent street corners, with placards giving age when [illegible] etc. The per capita cost of the Parsons proposed improvements was shown to be less than that of about 25 cities similarly situated.

The generation of electricity for operating the water pumps over a 10-mile transmission line to the river station and also low service pumps at the city station, lighting the grounds, stations, etc., was a part of the improvements, this energy produced by a private company supplying all electricity to the city. This feature furnished a basis for municipal ownership with all its advantages to be shown by the engineers.

The publicity campaign through the press and by personal presentation of the plan before civic organizations continued for four weeks, with an intensive speaking campaign for one week when 21 meetings were addressed, in explaining the engineering, economic and health features of the project. Noon meetings were addressed when factory, shop and office employes were reached. Slides were distributed daily to all the picture shows, showing some special features of the improvements. Local speakers were organized and "Four-minute" talks at all picture shows were made during the closing week. Church announcements were made, calling attention to the necessity of good citizens voting either for or against but leaving them to form their own conclusions.

The women voters, through the Parsons Federated Women's Clubs, sponsored the final mass meeting, bringing before the women voters the importance of the water supply from the standpoint of health, hygiene sanitation, beautiful lawns, clean streets, swimming pools, school and street drinking fountains, etc.

Various business men co-operated and jointly carried full-page advertisements recalling former water famines, bad fires, and showing what the new improvements could offer in the way of securing new industries in Parsons.

Home owners were clearly shown by figures that not a dollar of taxes would be added, but that the revenue would make the plant self-supporting.

The engineers conducting the campaign had the support and active aid of the Mayor, but no aid or co-operation from one of the Commissioners, and the active opposition of the other Commissioner, until two days previous to the election, when his conversion occurred and the three united in a printed statement favoring the bonds. Other early opposition gradually melted away as the project became understood and those who had opposed came out in print favoring the bond issue. In their articles and talks the engineers refrained from directly urging the voters to support the bonds, but took the position of a disinterested consulting physician to a sick utility, and presented their prescription for the patient in the form of plans, estimates and report, and all features of these were clearly explained, leaving the voters to form their own conclusions how they wanted to vote.

Activities of Mayors' Unemployment Committees

Two hundred and nine out of the 327 cities in the United States whose population is 20,000 or more have organized mayors' emergency committees in accordance with the recommendations of the President's Conference on Unemployment or have signified their ability to carry out the recommendations of the conference with machinery already in existence, states the December Monthly Labor Review of the U. S. Bureau of Labor. Many of those cities not organized are so situated that there is no grave local problem.

These figures were the salient features of a report recently made to the standing committee of the conference by Col. Arthur Woods, chairman of the special committee on civic and emergency measures created by the president. Col. Woods' figures, officials of the conference said, mean that the coordination of municipal agencies to meet the unemployment crisis, expected to reach maximum intensity in January or February, is virtually complete.

The states most thoroughly organized to date are Massachusetts, Illinois (with the exception of Chicago), Connecticut, Michigan, California, Oregon, Washington and Georgia. The states where the situation appears to be acute and where a considerable start has been made, though numerous cities are yet to be organized, are New York, Pennsylvania, New Jersey, Ohio, Rhode Island and Texas. Reports from Texas indicate that the situation there is being aggravated by a winter influx of Mexicans.

Recognition of an Undepreciated Rate Base in Some Recent Decisions

By W. H. BLOOD, JR.

[Many students of public utility rate problems have always felt that the so-called "present or depreciated value" of property is not proper as a base on which to calculate a percentage of fair return. Early court decisions, however, lead to the practical establishment of "depreciated value," and with this intrenchment it has occupied a very nearly secure position. Recently the opposite view has received certain judicial and commission encouragement, and it is Mr. Blood's valuable collection of references on this subject which we print here. These appeared in an article entitled "The Passing of 'Depreciated Value' in Rate Cases" in the Stone and Webster Journal of December, 1921. We omit the first part of the article, in which Mr. Blood presents a strong argument in favor of an undepreciated base, and present only the latter part, in which the various cases are cited and quoted.—Editor, Engineering & Contracting.]

Elsewhere in this case (Knoxville vs. Knoxville Water Co., Jan., 1909) the Supreme Court said:

> A water plant with all its additions begins to depreciate in value from the moment of its use.

This statement is quoted frequently by those who believe in using depreciated value as the rate base. The Supreme Court, however, did not mean that the value of the property as a going concern gradually disappeared, for, in the same decision, it clearly affirms the contrary, saying:

> The company is not bound to see its property gradually waste, without making provision out of earnings for its replacement. It is entitled to see that from earnings the value of the property invested is kept unimpaired, so that at the end of any given term of years the original investment remains as it was at the beginning. It is not only the right of the company to make such provision, but it is its duty. . . .

If the company keeps up its repairs, then, in the words of the Supreme Court, the "value of the property invested remains as it was at the beginning." If this is the case, there is certainly no authority in this decision for deducting anything for theoretical accrued depreciation.

As early as 1911, the master in the Minnesota rate case, after making a most exhaustive study of depreciation, expressed similar views and the findings of his report were sustained by the Circuit Court. Unfortunately, however, the Supreme Court in its decision in this case expressed the opinion that the master's methods of reaching his conclusions were rather "loose." Whatever may have been his methods of forming his opinion, it appears in the light of present thought on this matter that his conclusions were sound. His statement is as follows:

> A large part of the depreciation is taken care of by constant repairs, renewals, additions and replacements, a sufficient sum being annually set aside and devoted to this purpose so that this, with the application of modern art and adaptation to the needs of the country and of the public served, together with working capital . . . fully offsets all depreciation and renders the physical properties of the road more valuable than their cost of reproduction new.

One of the first cases in which the court expressed its views clearly on this subject without any qualifications or ambiguity, was on July 1, 1915, when in the case of Murray vs. Public Utilities Commission, the Supreme Court of Idaho said:

> As regards depreciation, we believe the Commission may well hold along the following lines: We think deductions should be made only for actual, tangible depreciation, and not for theoretical depreciation, sometimes called "accrued depreciation."

Taking its queue from the decision of the Supreme Court the Idaho Public Service Commission, later in the same year (October 2, 1915) in the case of the City of Sandpoint vs. Sandpoint Water & Light Company, Ltd., elaborated on the theory that to depreciate capital investment was unsound economics. The Commission called the proposition absurd, and even went so far as to call it confiscation and to say that if such a course were followed it would drive capital out of the state. A part of the decision is as follows:

> Included in the defendant's capital investment are certain items of physical property which are subject to decay, or will wear out and be replaced from time to time during the conduct of the business. In order to compensate the investor for loss in the public service of property through wear and decay, and to enable

him to make necessary replacements [illegible] time an allowance is made for him for depreciation, [illegible] ance should be treated as an operating expense. As [illegible] parts of the plant wear out they must be replaced [illegible] investment is thus kept intact. What concerns the [illegible] value of the service. It is impossible to keep the [illegible] new." To do so would be the rankest kind of waste. [illegible] the plant is partly worn out but in condition to [illegible] same efficient service as when the plant was new, the [illegible] lost nothing. The loss belongs to the investor, unless [illegible] been allowed a sufficient amount to offset the depreciation. [illegible] the capital investment and consequently reduce the earning power of the investment by reason of the fact [illegible], which are not at the time in question necessary, would in effect be confiscation. Suppose the investor has issued bonds on the property in order to make the investment. How can he pay the interest on the bonds if the earning power of the property is decreased? He could do so only by reducing the indebtedness to the extent of depreciation, which would vary from time to time. The absurdity of such a proposition from a practical standpoint would be apparent. If the rule of depreciating the investment by the amount of depreciation should become the established policy in this state, we can see very little inducement for the investment of capital in Idaho.

Similar views to those expressed by the Idaho Public Service Commission were voiced by the regulatory body of the conservative State of Maine in the case of Butler vs. Lewiston, Augusta & Waterville Street Railway. In this case on March 28, 1916, the Public Service Commission said:

> If a public utility company is spending a sufficient amount each year to properly maintain all of its property, and as a result thereof its plant is rendering nearly 100 per cent service, it would be unfair to deduct any considerable amount for depreciation, for the reason that the company would thereafter receive its return upon this reduced value, and being obliged to charge and receive no more than reasonable rates upon a fair value, would never be able to obtain a sufficient amount to place and maintain its particular property in proper and efficient condition. In the case of a street railroad, its track, its roadbed, its poles and wires, its car barns, shops, and power houses are ordinarily by maintenance kept in such state of repairs that there is never very much actual depreciation. Its equipment of cars, on the other hand, necessarily depreciates, and a certain reserve should be maintained to care for this depreciation. As a matter of fact, the respondent company maintains its roadbed, tracks, poles, wires, car barns, and power plant in excellent condition; it maintains such a depreciation reserve upon equipment as satisfies the requirements of the Interstate Commerce Commission. In the absence of evidence that this is not sufficient, we ought to be satisfied and, for the reasons above stated, we do not in this particular case feel that there should be any reduction from the above amount of $199,781.50; and we therefore find that this amount is the fair value of the respondent's property used and useful in the service of the public, as above outlined, such values being as of the date of the complaint in this case.

About a year later, on May 2, 1917, the District of Columbia Public Service Commission, for the first time in the history of rate cases, brought out clearly the difference in value for the purpose of sale as contrasted with value upon which to base rates. The decision showed clearly that the public is interested primarily in service, and that as long as the property of the utility is maintained so as to give good service depreciation is of no concern to the public. The decision, as far as it has to do with this subject, is as follows:

> Were fair value being determined in this case as a basis for purchase, the Commission is of the opinion that there would be no question in law or in equity but that accrued depreciation, as determined by its engineers, should be deducted. The Commission, however, is here finding fair value as a basis for rates. What may be fair or not to a purchaser, either private or public, is not now under review. The relationship of the matter of accrued depreciation to the Commission's final finding of fair value must, therefore, be from the standpoint of equity as between the rate payers and the company. The question now involved is, How and to what extent is the ratepayer interested in the accrued depreciation of the company's physical property. Briefly, the ratepayer is interested, and has the right to be interested, in the quality, extent and continuity of service rendered and in the fairness of the rates charged therefor. The property being to all intents and purposes devoid of deferred maintenance and in first-class service condition, the interests of the ratepayer as to present quality of service, so far as the matter of depreciation is concerned, are satisfied.

The Massachusetts Public Service Commission, which, with its predecessors, is one of the oldest in the country, clearly stated its position as far back as August 31, 1916, in the Bay State rate case, in which it says:

> In other words, the company is held to the same standard of honesty and prudence in the [illegible] maintenance [illegible] the original acquisition of its properties. It must, so far at least as it reasonably can, keep [illegible] good. If through some fault of its own, it has [illegible] provision for depreciation, it cannot reasonably [illegible] the public to pay a return on that portion of the [illegible] it has neglected to preserve. But under a [illegible] of the investment theory, it would seem in general [illegible] should be made for the depreciation which comes from [illegible] in so far only as the failure to make provision [illegible] to the payment of unwarranted dividends or [illegible] attributable to mismanagement.

In the decisions already quoted it is evident that the courts and commissions, as time has gone on, have become more and more imbued with the idea that current maintenance takes care largely of depreciation, and that being the case, it is obviously unfair to deduct an amount based upon theoretical assumptions for so-called "accrued depreciation." The Supreme Court of Oklahoma, in its decision in the case of Pioneer Telephone & Telegraph Company vs. State of Oklahoma on September 25, 1917, further clarified the situation as follows:

> In the case at bar, as we have seen, the Commission made no deduction from the value of the plant on account of depreciation but allowed returns upon its value as a going concern, kept up to a high degree of efficiency by replacements paid out of current revenue. There is no principle of public regulation more firmly established than the right of the company to charge in its rates an amount which will enable it to make these replacements, and as investors put their money into public utilities for the sake of the returns they will be able to obtain, if the allowance for replacements is sufficient to keep up a high degree of efficiency and prevent a lowering of the ability of the plant to earn returns we are unable to perceive the necessity for building up a fund to be used for the purpose of counteracting a purely theoretical depreciation. The theory of the Commission seems to be that charges should be made in rates sufficient to counteract or prevent depreciation by replacements, and that when replacements are thus fully provided for, depreciation is counteracted. We see no error in this, at least, none of which the appellant company has any just cause to complain.

As pointed out earlier in this article, all utilities cannot be treated alike. The above case had to do with a telephone company; it might very well follow that an electric light and power company, in addition to caring for current maintenance, should also be allowed to provide for the retirement of the larger items by the creation of a reserve for this purpose.

On October 8, 1917, the Colorado Public Utilities Commission, in the Intermountain Railway, Light & Power Company case, said that in the early decisions of the courts and commissions the value spoken of was sale value, while that which should have been considered was value for rate making. They said very properly that in one case depreciation should be considered and in the other that it should not be considered. The following extract from the decision is illuminating:

> The early decisions of both courts and commissions appear to have almost universally held that some deduction on account of accrued depreciation should be made, although the majority of the earlier court decisions are cases involving the fair value of the property for purchase or transfer, rather than for rate making. Whether or not such deductions as were made were based on so-called theoretical depreciation or on the depreciation determined by actual inspection is by no means clear from a reading of these earlier decisions, and as a result the question of whether or not theoretical depreciation or actual depreciation as determined by inspection should be deducted from the original cost or reproduction cost, as the case may be, has been presented many times to regulatory bodies.
>
> The Commission is therefore of the opinion that, in arriving at the fair value of the property of a public utility for rate making purposes, deduction on account of depreciation should not be made for the reason that property is old, obsolete, inadequate, or otherwise incapable of giving good service. Obviously, if the property were found in such a condition that reasonably good service could not be had, it would be the duty of the Commission to require that property to be put into condition to give good service before entering upon a determination of fair and reasonable rates. If, in the inventory of physical property, only such items as are in use and useful, in reasonably good service condition, and necessary to the proper operation of that property, are included, the element of depreciation—at least in so far as wear and tear and obsolescence, and inadequacy affect the fair value of the property for rate making purposes—will have been sufficiently taken into account.

In the case of Ben Avon vs. Ohio Valley Water Company, the Public Service Commission of Pennsylvania made large [illegible] for depreciation in determining [illegible]. The Ohio Valley Water Company appealed this case to the Superior Court of Pennsylvania, which ordered the Commission's ruling reversed and directed it to redetermine the valuation in accordance with certain lines [illegible] by the Court. On the matter which we are discussing, the court on October 8, 1917, said:

> Depreciation [illegible] which is [illegible] largely [illegible] A rate [illegible] and it, [illegible]

In the case of the Utah Light & Traction Company, the Utah Public Utilities Commission on December 29, 1917, ruled against deducting theoretical accrued depreciation, saying:

> This Commission may well hold along the same lines as the [illegible] Supreme Court. So far as the question of depreciation is concerned we think deduction should be made only for actual, tangible depreciation and not for theoretical depreciation, sometimes called accrued depreciation. A way must be found to insure investors with certainty the return of their investment will [illegible]

This is simply another way of saying what the writer contends—that the investor is entitled to a return on the full undepreciated value of his investment.

That it is profitable to express one's views in order to assist the commissioners and even the courts in coming to sound conclusions where economics enter, is shown by the finding of the Washington Public Service Commission on June 30, 1919, in the case of the Kelso Water Company. The Commission said:

> We believe there is thought worthy of consideration in an article entitled "Theoretical Depreciation" by George E. Webster of New York, wherein he states:
>
> "The advocates of the depreciation theory would state the formula in this way. A unit of equipment costs $10,000, it has a life expectancy when [illegible] of thirty years, ten years have elapsed, ten years is one-third of thirty years, one-third of $10,000 is $3,333.33, thus deducted from the 'cost' leaves the 'present value' of the unit of equipment as $6,666.67.
>
> "It is not conceivable that anyone could give the subject of depreciation of the kind here illustrated serious consideration without discovering its utter fallacy. That so few have raised their voices in protest against it must be attributed to the fact that few have considered it seriously. Those who are unalterably opposed to the theory include some economists, some members of the judiciary, a few of the Public Service Commissions, some executives of corporations, and some members of the legal, engineering and accounting fraternities. They have discovered that the question is not one of engineering nor of accounting, but one of economics and finance and the legal protection of property rights."

All the following quotations from court decisions and public service commission findings were expressed in the year 1920, showing quite conclusively that opinion on this subject is crystallizing and that the use of depreciated value as a basis upon which to fix rates is passing.

In the case of Pacific Gas & Electric Company vs. City and County of San Francisco, the master indicated that he had made a careful study of this matter of depreciation and discussed at some length the various phases of the situation. In his conclusion he said, on March 2, 1920:

> [illegible] the point [illegible] that it is misleading to [illegible] is not new.

In the early days of its existence the Wisconsin Public Service Commission had a habit of deducting something for depreciation in ascertaining value, and at the same time it added substantially the same amount for going concern value, and so came back to the value it started with. This plan it abandoned several years ago. The Hon. Carl D. Jackson, chairman of the Commission, in a public address given in May, 1920, left no doubt in the listener's mind as to his views on this subject. His views are remarkably clear and convincing. He said:

> The concept of value as which attaches to exchange of commercial value of marketable commodities has, I believe, led directly to a misconception of the effect of accrued depreciation [illegible] at a rate base. It can hardly be otherwise under such concept. Everybody knows that a used machine or automobile is not as valuable and will not sell for as much as a new one. Why should not public utility property be subject to the same exchange or commercial laws, and, if value is exchange, commercial and [illegible], it is hard to explain why commercial and exchange elements relating to use should not be an applicable factor. If, however, you exclude this concept of exchange value and think of value as closely related to legitimate investment, which in turn represents the sacrifice made by the owners of the utility, the mind is at once freed from this question, and the question of accrued depreciation, that is, accrued liability to replace, immediately becomes connected with the question of depreciation reserves, failure to set aside depreciation reserves where they could reasonably have been set aside, and the question of return to the investors of a part of the investment made by them. If value in the long run is somewhat [illegible] to investment, then every rule of equity demands that the question of accrued depreciation shall be considered in connection with the question of the investment still in the utility, and if the investors have left the investment in the utility and the utility has been properly maintained and reserves set aside, it becomes clear that there is no justice in depreciating the rate base.

Concluding his address, he definitely affirmed that on this matter of depreciation there was getting to be a unanimity of opinion. His exact words on this subject were:

> Various commissions in the country are coming to be more of a unit on the question of accrued depreciation.

In the case of the Consolidated Gas Company vs. Newton, August 4, 1920, Judge Learned Hand brought out this idea very clearly when, in commenting on an engineers' estimate of "straight line" depreciation, he said:

> This was necessarily a conjecture, based upon supposed life of the plant; it has no application while the plant is kept up.

In many of the recent decisions the courts, from their very language, show that they have little patience with the engineers who theorize on the matter of depreciation.

In the decision in the case of New York and Queens Gas Company vs. Newton, et al., the special master ruled and the Federal Court, on November 19, 1920, agreed with him, that there should be no deduction from actual investment on account of accrued theoretical depreciation. In the opinion we find the following statement:

> In determining that the complainant's property has a fair present value of at least the amount of the complainant's actual investment therein . . . I have made no deduction for what is termed "depreciation" in whatever way calculated. Under any basis of determining present value, the complainant's property is now worth at least the amount of such investment therein and the sound rule of law and policy seems to require the allowance of a reasonable return upon at least that sum.

Not only are the courts and commissions coming to adopt the theory that when a property is kept up there is no depreciation, but even the attorneys representing the United States Government are insisting, so far as steam railroads are concerned, that this is the case.

One of the most interesting contentions made by the Government attorneys is found in the recent case of the Nashville, Chattanooga & St. Louis Railway Company vs. United States before the United States Circuit Court of Appeals. In the brief filed on behalf of the United States on December 7, 1920, we find the following argument:

> . . . The Government proved that the renewals and replacements, together with the repairs which were made, maintained the roadway, and, in fact, kept the roadway in as good or better condition at the end of each of said years as it was at the beginning of each of said years, and that therefore there was no depreciation.

Farther on in this same brief, it is stated that it is "the theory of the Government" that the usefulness of the railroads determined their value and the following statement appears:

> If their usefulness remains the same, their value also remains the same; if their usefulness is increased, their value is correspondingly increased; if their usefulness is decreased, their value is likewise decreased. It is obvious, therefore, that whatever increases or reduces the usefulness of railroads correspondingly increases or reduces their value. In this connection, it is well known that wear and tear, etc., reduces the usefulness and

consequently the value of the railroads. On [illegible] equally well known that repairs, re[illegible] parts increase the usefulness and consequently the value of railroads. It is also well known that the [illegible] wear and tear is the occasion for repairs, renewals [illegible] parts and that, with the roadway and oth[illegible] managed, railway companies' wear and [illegible] than renewals and replacements are [illegible] place simultaneously and tend to counte[illegible]

Later on, in this same brief, we find this statement:

> It is apparent that the service life [illegible] perpetual and that the repairs, renewals and replacements which were made to it . . . eliminate both [illegible] depreciation or any other kind of depre[illegible].

Methods and Cost of Maintenance of Drains on U. S. Reclamation Service Projects

Interesting information on the maintenance of open and tile drains on the irrigation projects of the U. S. Reclamation Service is given in the January Reclamation Record by Mr. C. E. Lounsberry, assistant to drainage engineer of the U. S. Reclamation Service. The notes following are taken from the above mentioned publication.

OPEN DRAINS.

Soil.—The type of soil encountered is an important factor in maintenance, because erosion and silt deposit are causes of expensive work. For purposes of drainage, soils may be divided into two classes; those which give up their water readily and hold their slopes [illegible] and those which do not give up their water readily and will not hold their slopes. Of the soils usually encountered, sand and gravel are in the first class, and silt, clay, sandy silt, and shale are in the second class. Although sand flows readily when fully saturated, it soon gives up the greater part of its water when drainage is provided. Coarse sand and gravel are the most desirable soil through which to maintain drains. The soils in the second class, on the other hand, hold in the form of capillary and hydroscopic water probably the larger proportion of the water originally contained. They erode easily and flow readily when saturated and thus will not maintain true slopes.

Floods.—Floods increase the expenditure for maintenance by the erosion and silting of drains and the washing out of structures. It is impossible to design drains which will always be flood proof because grades must conform to surface slopes and these are frequently steep in the upper reaches and become much flatter as the outlet is approached. This results in erosion where velocities of flow are excessive, and in deposition of material where velocities are decreased because of flat grades. Again, it is readily seen that if drains are designed to carry infrequent, abnormal flood discharges, the velocity will be so small during normal flow that a great deal of silt will be deposited. Vice versa, if they are designed for the normal seepage flow, the flood flow may destroy them. The usual procedure is to provide sufficient capacity for the maximum usual annual flow and repair damage done by abnormal flows which occur at infrequent intervals.

Plant Growth and Debris.—The growths which commonly

TABLE I—UNIT COSTS OF MAINTENANCE OF OPEN DRAINS CONSTRUCTED AND MAINTAINED BY THE U. S. RECLAMATION SERVICE

Project.	Period Dates.	Period Number of years.	[illegible] of total [illegible] (miles).[1]	Unit detail costs per mile-year Patroling. Per mile year	Patroling. Per cent	Clearing of weeds and debris. Per mile year.	Clearing of weeds and debris. Per cent.	[illegible] Per mile-year	[illegible] Per cent
Carlsbad	1917-1921	[illegible]	[illegible]	$18.44	12.8	$17.71	12.5	[illegible]	41
Huntley	1917-1921	[illegible]	16.00	.48	0.8	7.08	13.4	[illegible]	58.4
Klamath	1917-1921	4	82.[illegible]	.02		4.88	12.7	18.34	48.8
Newlands	1917-1921	4	[illegible]	31.96	17.4	21.57	11.7	47.[illegible]	25.[illegible]
North Platte (Interstate)	1917-1921	4	34.21	13.03	6.6	17.71	[illegible]	[illegible]	11.5
Rio Grande	1918-1921	[illegible]	[illegible]	9.00	16.4	29.16	[illegible]	[illegible]	[illegible]
Shoshone	1917-1921	[illegible]	[illegible]	.90	3.2	8.35	[illegible]	[illegible]	[illegible]
Umatilla	1917-1921	[illegible]	10.00	[illegible]	....	61.47	[illegible]	56.80	37.8
Yuma	1918-1921	[illegible]	[illegible]	..	....	23.48	[illegible]		
Totals and averages	1917-1921	4.37	351.13	$[illegible]	8.5	$17.96	[illegible]	$[illegible]	[illegible]

Project.	Unit detail costs per mile-year Repairs to structures. Per mile-year	Repairs to structures. Per cent	Minor expenses and plant and equipment. Per mile-year	Minor expenses and plant and equipment. Per cent.	Miscellaneous. Per mile-year	Miscellaneous. Per cent.	Unit field cost per mile-year	Overhead Per mile-year	Overhead Per cent	Total unit cost per mile-year	Average cost per year
Carlsbad	$3.41	2.4	[illegible]	[illegible]	$1.00	0.7	$99.05	$42.26	[illegible]	$141.[illegible]	$1,[illegible]
Huntley	3.73	7.6	3.41	[illegible]	3.82	7.8	47.06	1.94	[illegible]	[illegible]	[illegible]
Klamath	6.4[illegible]	16.8	.03				30.24	8.33	21.[illegible]	[illegible]	[illegible]
Newlands	15.31	8.3	[illegible]	[illegible]	11.20	6.1	[illegible]	51.36	[illegible]	[illegible]	[illegible]
North Platte (Interstate)	[illegible]	[illegible]	[illegible]	[illegible]			156.89	[illegible]	[illegible]	[illegible]	[illegible]
Rio Grande	.71	1.3	[illegible]	[illegible]	.74	1.4	[illegible]	[illegible]	11.6	[illegible]	[illegible]
Shoshone	12.[illegible]	[illegible]	[illegible]	[illegible]	.26	0.9	24.65	3.91	13.7	[illegible]	[illegible]
Umatilla	1.[illegible]	1.2	[illegible]	[illegible]		...	[illegible]	[illegible]	14.6	[illegible]	[illegible]
Yuma	..	...	[illegible]	[illegible]	[illegible]	[2]82.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Totals and averages	$11.63	16.2	[illegible]	[illegible]	[illegible]	[3]1.3	[illegible]	[4]$14.76	[illegible]	[illegible]	[illegible]

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[1] The average of the total miles of open drain for the years considered, not the mileage on which maintenance was actually done.
[2] This represents the operation of two permanent pumping plants, including overhead expense.
[3] Does not include Yuma pumping plants.
[4] Includes Yuma pumping plants.

TABLE II—UNIT COSTS OF MAINTENANCE OF CLOSED DRAINS CONSTRUCTED AND MAINTAINED BY THE U. S. RECLAMATION SERVICE

Project.	Period Dates.	Period Number of years.	Average of total length of drains in project (miles).[1]	Unit detail costs per mile-year Patroling. Per mile year	Patroling. Per cent	Clearing tile and trap boxes. Per mile year	Clearing tile and trap boxes. Per cent	Repairs to tile and trap boxes. Per mile year	Repairs to tile and trap boxes. Per cent.
Carlsbad	1917-19[illegible]	[illegible]	[illegible]	...		[illegible]	[illegible]	[illegible]	[illegible]
Huntley	1917-1921	[illegible]	47.52	$[illegible]	0.2	[illegible]	[illegible]	[illegible]	[illegible]
Klamath	1919-19[illegible]	[illegible]	8.00			5.96	[illegible]	[illegible]	[illegible]
North Platte (Interstate)	1917-19[illegible]	[illegible]	14.2[illegible]	1.29	1.4	[illegible]	57.2	[illegible]	22.7
Newlands	1918-19[illegible]	[illegible]	[illegible]						
Shoshone	1917-1921	[illegible]	81.17	.50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Totals and averages	1917-1921	3.56	158.53	$0.73	0.9	$14.72	[illegible]	[illegible]	12.6

Project.	Unit detail costs per mile-year Minor expense and plant and equipment charges. Per mile-year	Minor expense and plant and equipment charges. Per cent	Replacement of [illegible] Per mile-year.	Replacement of [illegible] Per cent.	Hydrometry Per mile-year	Hydrometry Per cent.	Unit field cost per mile-year	Overhead Per mile-year	Overhead Per cent	Total unit cost per mile-year	Average cost per year
Carlsbad	$1.24	1.3					[illegible]	$36.76	[illegible]	[illegible]	$264.37
Huntley	3.08	3.6	[illegible]	[illegible]	.		[illegible]	[illegible]	[illegible]	[illegible]	4,015.04
Klamath	.....	..			...		[illegible]	2.33	[illegible]	[illegible]	69.25
North Platte (Interstate)	4.80	[illegible]					[illegible]	[illegible]	13.4	91.22	1,295.3[illegible]
Newlands	10.[illegible]	5[illegible]					[illegible]	7.14	[illegible]	[illegible]	[illegible]
Shoshone	1.00	4.[illegible]			$0.02		[illegible]	2.65	13.2	[illegible]	1,637.34
Totals and averages	$2.54	4.3	$2.15	3.6	$0.01	...	$50.95	$ 7.98	13.5	$58.93	$9,342.51

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[1] The average of the total length of closed drains for the years considered, not the mileage on which maintenance was actually done.

occur in drains are cattails, Russian thistles, and moss. Debris is washed and blown into the drains from the surrounding land. It floats downstream until a lodging place is found, where it gradually accumulates and forms a barrier. [illegible] crossings are objectionable on this account, for unless their bottoms are higher than the maximum water level they catch floating debris and form an obstruction which ponds the water above.

Tumble weeds are a constant source of trouble. The drain banks form windbreaks and intercept those which are carried by the wind from the surrounding land to be dropped into the channel, where they gradually pile up and obstruct the flow. They are easily burned when dry, but when wet must be removed from the drain.

Structure Repairs.—Repairs are usually made necessary by the action of surface water flowing into the drains, and where this water can be diverted from around the structures the repairs are reduced to a minimum. Burrowing animals also contribute to structure washouts by burrowing under and around cut-off walls, allowing water to get behind and under structures and undermine them.

CLOSED DRAINS.

Soil. Tile drains to function properly must be kept true to grade and alignment. If the soil surrounding the tile is not sufficiently stable to support it, the tile will become misplaced and the grade alignment will be destroyed, causing silt to deposit and the tile finally to collapse. Failures may occur soon after construction or after years of service, and they have occurred even when the tile was laid on wooden cradles.

Floods. Most of the flood damage to closed drains occurs at the outlet of the drains by washing out the protecting bulkheads. It is very important not to place a tile drain outlet in a natural depression where flood waters are liable to flow. Where this is done, surface water flowing along the depression may wash out the bulkhead and sometimes uncover the tile for a distance above it.

Plant Growth and Debris. If trap boxes are built with their tops above the ground surface and are kept closed, there is no opportunity for debris to enter the tile. The tops are sometimes left open, however, or boards are pried from the sides for the purpose of dipping out stock water or for allowing unusual flows of surface water to enter. Buckets sometimes get away from the person dipping the water and lodge in the tile where they are very difficult to dislodge, often making it necessary to uncover and remove the tile. Where surface water is allowed to enter, it carries with it some debris, part of which may be caught in the box and part of which may go into the tile.

Plant growth affects closed drain maintenance by means of the roots entering the tile through the joints and filling them. The worst offenders are willow roots, with alfalfa roots a close second. The roots enter the tile through the joints and multiply very rapidly inside, forming a fine dense network often resembling fine-cut tobacco. They finally clog the tile completely. This difficulty is a serious problem in maintaining closed drains and one of the hardest to combat.

MAINTENANCE METHODS.

A preventive in maintenance work is worth more than a cure. The rapidity with which conditions become worse has been emphasized in the foregoing discussion and it is much better to forestall conditions which will decrease the efficiency of the drains than to remedy them after they have reached serious proportions. This holds for both types of drains.

Open Drains. Patrolling may be considered as a preventive, and the cost of this item is money well spent. A ditch rider, by calling attention to a condition at its inception or by doing a few minutes' work himself at the proper time, may save large future expenditures.

Silt and caved material should be kept cleaned from the drain bottoms. Where a large system of drains is involved, a small drag line excavator traveling either on the crown of the bank or on the berm, is the best machine for cleaning. The original bottom width and grade line should be maintained as closely as possible. In connection with this, all drainage inlets should be kept clear and in repair. Otherwise surface water will accumulate until it flows over the banks, depositing the material from the banks in the bottom of the drain. Where the soil will not maintain a true slope, it is frequently necessary to construct wire or brush protective work at the toe of each slope to keep the channel clear.

Weeds and debris should be removed at frequent intervals and not allowed to collect until erosion and silt deposit have resulted and the bottom become crooked. In one case a wire fence supported on steel posts has been erected to catch tumble weeds before they blow into the drain, the weeds being burned on the fence at intervals. Inflammable debris is removed from the drain and burned when dry. Non-inflammable material is thrown out where it can not get into the drain again.

Repairs to structures should be made as soon as the need for repair exists. Small washouts around structures can be repaired by a few shovelfuls of earth thrown in by the ditch rider. Larger repairs may require a crew of men. In connection with this and also with the sloughing in of banks it is necessary to exterminate burrowing animals, such as muskrats, pocket gophers, and ground squirrels. The most effective method of extermination is by poisoning. Shooting is often resorted to, but is less effective.

Closed Drains.—Patrolling bears practically the same relation to closed drains that it does to open drains. The ditch rider should see that all drains are operating properly by an inspection from the trap boxes and should see that trap boxes are kept closed. Foreign material, such as silt and debris, should be removed from the boxes before it attains a depth that will cause it to pass into the tile. Silt is usually cleaned out by dipping with a water bucket having holes punched in the bottom to allow the water to drain through.

Deposition of silt in the tile is not a serious problem as the natural flow of water usually prevents it. The usual obstructions are caused either by roots or by the tile breaking or settling. The only remedy in either case is to uncover the tile and remove the obstruction. Prevention is again the best policy. The growing of roots in the tile can be largely overcome by removing all trees within a distance from the drain from which the roots would be liable to reach it, and by prohibiting the planting of deep-rooted crops directly over the drain. An effort has been made to procure a chemical which would kill the roots in the tile, but nothing satisfactory has yet been found.

Maintenance Costs of Open and Closed Drains.—Tables I and II give maintenance costs for open and closed drains on the projects of the Reclamation Service for periods averaging 4.37 and 3.56 years, respectively. These periods are too short to justify any general conclusion as to what the relative maintenance costs of the two types of drains will be over an extended term of years. It is thought, however, that they may be found of interest as showing actual maintenance costs for the periods covered on the various projects.

Personals

W. H. Davolt has resigned as manager of the Water Department of Kelso, Wash., and will engage in business.

Dr. Wm. Paul Gerhard, C. E., has recently removed his office from 311 Audubon Ave. to 17 W. 42nd St., New York City.

Burton L. Winslow, of the engineering department of Akron, O., has been appointed the first city manager of Stoughton, Mass.

Charles S. Henning, Jr., engineer of Hill County, Texas, has resigned to accept the position of district engineer with the State Highway Department with headquarters at Fort Worth.

Chas. F. Puff, Jr., formerly assistant chief Bureau of Highways of Philadelphia and later secretary and general manager of the Associated Pennsylvania Highway Contractors, has established an office at 1615 Real Estate Trust Bldg., Philadelphia, where he will engage in a consulting and contracting service for contractors, engineers and commissions. In addition he will publish a weekly news service and a monthly digest of public construction for the metropolitan district of Philadelphia.

Alvord & Burdick, consulting engineers, Chicago, announce that the firm will hereafter be known as Alvord, Burdick & Howson. Louis R. Howson, whose name is now identified with the firm, has been a member of the organization for the past 15 years as assistant, principal assistant and partner. As in the past, this firm will continue in the practice of engineering particularly related to the problems of water works, water purification, sewerage, sewage disposal, flood relief, drainage, power generation, appraisals.

J. D. Fauntleroy, district engineer of the Sixth Federal Aid district, which comprises the states of Arkansas, Oklahoma, Louisiana and Texas, has resigned his position with the Bureau of Public Roads to become state highway engineer of Texas. Captain Fauntleroy has been chief of the Sixth district since it was organized in 1917. Captain Fauntleroy was educated in Virginia Military Institute and has been in the federal engineering department since 1898. Prior to the Spanish war he was engaged mostly in railroad engineering. He served in the Spanish war and also in the Philippine insurrection. After leaving the army he was engaged in highway work in the Philippines for three years, then two years in sanitary engineering, five years in the reclamation service, one year as general manager of a construction company in Wyoming, and for the last eight years has been with the federal bureau of good roads.

Railways and Excavation Monthly Issue

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Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railway Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Management and Office System

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Solving Economic Problems in Blank

Although it is probable that few writers on economic matters have ever heard it stated that no economic problems can be solved until each of its elements is quantified, still there is a sort of subconscious recognition of this principle by many of those writers. Witness the following quotation from an article by Edwin J. Clapp on "An American Transportation System," in The New Republic:

"Take for example the illustration already given, of the five separate railroads serving an industrial section of a Middle Western city. Suppose we forbid the railroad carriers there to continue competitive services and compel them to unify. The result would be the abandonment of four branch lines and four stations, and the development of the best station and the best line to a capacity sufficient for all roads. The valuable real estate set free by the abandonment of duplicate lines and stations could now be sold and the proceeds returned to the railroads, which would henceforth be freed of the annual burden of interest, maintenance and operation of the relinquished property. Multiply such savings by the number of cities served by competitive railroads and the result would be an indication of the reduction in expense possible from unified railroad terminal operations."

Very good, but why doesn't Mr. Clapp do what he tells us in the last sentence to do? Why doesn't he "multiply such savings by the number of cities" and compute the total? Oh, because he is merely solving this problem in blank. His task, you see, is simply to tell us how to solve it, and then leave us and the data alone together. This might be satisfactory enough if he would collect the data for us; but he is solving in blank, you see, and is particularly blank on statistics.

Now it happens that this is typical of the way in which most of the would-be instructors of the public tell the public what the answer is to the problem they are reading about. Isn't it delightfully simple to solve economic problems in this fashion? All the drudgery and dourness of ferreting out the data, of analyzing them, and of finally producing a definite quantitative answer are thus escaped by the Mr. Clapps.

As engineers, most of us have learned that when we are assigned an economic problem—say the economic location of a branch railway—we must return with definite costs and values. We can't "get away with it" when we confront "the big chief" by handing him a neat little essay on how the problem can be solved. We must have a definite solution, together with the data to establish that our solution is really economic. But "the big chief" to whom the Mr. Clapps make their report is usually either an editor who knows less than he does about the problem, so he "gets by."

Having demonstrated that the problems can be solved, by solving it in blank, Mr. Clapp's next step is to imply that he has solved it, although he refrains from burdening us with the data of the solution. True, he does not say so, but what else are we to infer when he next proceeds to pass judgment on the uneconomic nature of railways as they are and the highly economic nature of railways as he would design them. He says:

"We have no American railroad system. The lack of system makes itself most severely felt in the planlessness and inconvenience of competitive railroad facilities in our large cities and in the enormous expense that these duplicate terminals impose on the rail carrier. The solution of the rail problem lies not in pursuing the chimeras of higher rates and lower wages, but in cutting out the vast terminal waste."

Speaking of the economic advantages of a common railway station, he asks:

"Would the shippers benefit? Certainly. An industrial location on a neutralized terminal line connecting with all carriers is preferable to a location on the line of a single carrier.

"The question asks itself: Why in the world do not the railroads themselves see the possibilities of such reductions in expenses? Why need they be forced to undertake these innovations so obviously to their own advantage?"

Of course, now that Mr. Clapp has presented such convincing arguments (plucked, shorn and bereft of all data), it will be obvious to all—even to a railway chief engineer—that the railway owners should rush out and raise the money for the necessary additions and betterments? No, why rush out? Let them merely dip down into their own pockets for the money. Haven't they gotten used to such dipping, after all these years of paying out much and taking in little? For of such is the kingdom of altruism.

How Politicians Menace Public Utility Commissioners

The recent decision of the Consolidated Gas case by the Supreme Court seems again, and emphatically, to direct attention to one of the worst phases of politics in America. We refer to the repeated attempts of many politicians to intimidate the judicial and semi-judicial bodies that decide what rates the public shall pay for transportation, light, water and power. We shall come in a moment to this particular decision and its rebuke to New York politicians. Let us first mention a few of the attacks by politicians on rate-making commissions.

Not long ago the California Public Utility Commission raised certain telephone rates. Whereupon a howl went up from many politicians—a howl in which even so reputable a paper as the Los Angeles Times joined. That influential periodical virtually said that the raise in telephone rates was unjustifiable. It joined the politicians in its outcry. Was its attitude due to ignorance or to a desire to strike a responsive chord with the public? We are safe in venturing to say that no editor of the Los Angeles Times had even read a tenth of the evidence in that rate case, to say nothing of having attempted to analyze the evidence. The Times is against Governor Stevens, whose "creature" it declares the commission to be, so why not bat the governor by batting the commission? Besides, the public will applaud anyone who favors low rates and low prices.

In Illinois some politicians decided to attack a public service commission that had raised certain rates. A governor was elected through the efforts of those politicians, and he immediately got rid of the commission that had dared to raise rates. Why not? Had not a governor in New Jersey recently done the same thing? Therefore was there not excellent precedent for getting rid of a "court" that fails to meet the desires of the majority of the public? Is this not a democracy in which all public servants must meet such desires? Could anything be plainer?

The Public Service Commission of the State of Washington, in common with every other courageous rate-making commission, has also raised some rates, notably in Seattle and Spokane, and now some of the "representatives of the people" of that state are threatening several things. They will either restrict the commission's powers by prohibiting it from regulating rates in cities of the first class, or they will make the commission elective instead of appointive, or both. Splendid strategy. If a commission against which no charge of dishonesty, or incompetency, can be sustained will not give us as low rates as we should like, curtail their power, or get a commission more amenable to our desires.

And the significant thing about this sort of political rottenness is that it is beginning to appeal to many daily papers that have hitherto been fair toward public utility corporations, or if not fair have at least refrained from attacks. Seeing that it is winning votes to attack rate-making commissions some newspaper owners have apparently decided that the same policy will win readers. At any rate they offer no sound reason for such attacks. They do not even intimate that the rate-making commissions are dishonest. They know better. But they argue speciously about evidence that they have obviously never read, and, reading, could not understand in its most important phases. What does the average newspaper editor know about such technical phrases as "load factor," "functional depreciation," "development cost," and the other hundred and one technical terms that abound in every rate case? Read the reports of a rate hearing as given in the average daily paper if you wish to see how far over the head of the average reporter most of the testimony is. Yet the very same paper that publishes the garble that is supposed to be a report of such a hearing will, like as not, later on carry an editorial condemning the decision of the commission! It would be to laugh, were it not so serious—serious not merely to the stockholders of railway and public utility companies, but to the millions who are employed by such companies, and to the public served by them.

Several years ago the legislature of New York State passed a law that restricted the Consolidated Gas Company to 80 cts. per thousand feet of gas. It mattered not that fuel and wages had doubled, the State of New York, through its politicians, insisted on continuance of a confiscatory rate for gas. The mayor of New York, most of the politicians in power and many of the newspapers fought to retain the 80-ct. gas rate. What did they care about justice to the stockholders of the Consolidated Gas Company? Was it not enough for them to know that gas consumers would prefer an 80-ct. rate to a $1.20 rate? The U. S. Supreme Court has ruled that the New York State utilities commission must fix a gas rate that is not confiscatory. Nothing that has recently happened has served so well to show up the rottenness of many politicians in some of our large cities. Following the Supreme Court decision, George B. Cortelyou, president of the Consolidated Gas Company, said:

"The unanimous decision of the nation's highest court is, of course, most gratifying to the trustees and officers of this company. For the last three years this company and its subsidiaries have been subjected to unsparing attack and systematic misrepresentation on the part of public law officers who sought to prevent the establishment of adequate rates.

"The most vindictive efforts were made to create public prejudice, confuse the issues, mislead our consumers and intimidate every one who suggested justice for this company. Even the federal judges of this district were vigorously and unscrupulously criticised for daring to find the facts and award substantial justice. Every essential contention of this company is unanimously sustained by the highest court."

But although rebuked in the most impressive way by the Supreme Court, some New York politicians are apparently going to continue to get something for nothing for the public. John P. O'Brien, corporation counsel of New York City, has indicated that he would continue the city's fight for lower gas—observe that he does not say "for justice." Then he added significantly that the public will hold the Public Service Commission responsible for future rates on gas!

This is a pretty mess, indeed. If it were of a sort found only in New York, Chicago, Detroit, San Francisco and a few other large cities, we might not worry much over the future of our public utilities and railways. But this sort of politics is typical rather than exceptional; and the American public has yet to realize the full rottenness of it. In the exposure of its rottenness, and of its consequent bad economic effect on the entire country, the organized engineers of America can play a leading part if they will. Will they?

The Public Utility Rate Base

Ever since the United States Supreme Court's decision in the "Nebraska Rate Case" in 1898 there have been honest differences of opinion as to whether railway and other public utility returns should be calculated as percentages of invested capital or as percentages of a "present value," not clearly defined, but most often calculated as "cost of reproduction less depreciation." In referring to "honest differences" we speak advisedly, for not only is it possible to differ honestly in such matters, but we recall actual instances of disagreement on the rate base between persons engaged on the same side of certain cases.

For the most part, however, one cannot escape observing a distressing reversal of attitude by the parties to these disputes during the past 10 years. In the early part of the last decade, when construction costs were low, the companies had much to say in favor of the investment basis as against so-called "present value," while the public's representatives stood as firmly in the opposite position, in which they were unquestionably supported by the body of judicial opinion. But since the post war rise of prices invested capital has appeared to many city attorneys and other public spokesmen as all that any utility ought to earn a profit upon; and there has been much clamor that it be substituted for the "value" basis. Simultaneously utilities' representatives have hastened to announce their adherence to the theory that "value" and not "cost" should constitute the rate base. All of this is but the working of poor human nature, upon which we are not called to moralize beyond the reflection that regrettable as these things are, there is evidence of an increasing sincerity in such relations.

As a matter of fact the calculation of return merely as a percentage of either "investment" or "value" is subject to serious objection, and one may properly [illegible] why no better basis is introduced. The Supreme Court, in the Nebraska Rate Case, made an excellent beginning, but unfortunately its decision has not been followed by further progress of a like order. There has been a far great readiness to treat court decisions as final, and [illegible] further the progress which should be made. It can hardly be contended that the respect due the courts requires the rejection of advancement beyond their [illegible].

Actual investment as a basis for rate regulation is properly objected to on the ground that in one particular case it may be excessive, and in another inadequate. "Reasonable investment," or what the property ought to have cost under reasonably good management at the actual time of its construction, while obviating these objections, is still subject to the criticism that it puts the financial status of regulated utilities on a different basis from those of other enterprises, by stabilizing them against price changes and business fluctuations, and so giving them a measure of advantage in times of depression and a handicap in times of prosperity. Lack of space here precludes discussion of the question whether or not governmental regulation so changes the character of an industry as of necessity to require a different basis for displaying its earning status.

In our issue of March 8 we printed an article citing some 15 recent cases in which either courts or commissions have ruled against "depreciated value" in spite of its earlier judicial sanction. Some of the reasons for dissatisfaction with the "value basis" are easily and quickly presented. In the first place as a business proposition, the value to owners or prospective purchasers is primarily dependent upon the rates charged; and the attempt to regulate rates by "value" involves a circular procedure leading nowhere. "Fair market value," even if it were directly ascertainable (which it is not for properties seldom traded, and for which no open market exists) affords no escape from the circle; and this combination of requirements and limitations has lead to the common use of "cost of reproduction less depreciation" as a substitute.

Such a base can be made to change with every day's depreciation and with every change in the prices of labor and materials; but it does not follow, as some argue, that logic requires correspondingly frequent changes in rates charged. Changes at reasonably long intervals could be made to provide fairly for the price changes. However, in periods of extreme fluctuation, as in the past 6 years, it involves real difficulties and objections. Much more serious is the fact that in most cases cost of reproduction is a hypothetical thing whose very existence involves contradictory as well as arbitrary assumptions—contradictory in such assumptions as that an utility is to be constructed new and entire in a community which is the same as the existing one in all respects except the complete absence of the utility under consideration; arbitrary, for instance, in the selection of an exact date at which construction prices are to be taken.

But still other defects appear in either "cost" or "value" as a sole basis for estimating return and determining regulation. Neither is of universal applicability. The extreme case, in which there is not even an attempt to use them, occurs with those utilities which do a large business with very little plant investment, such as the express companies. From these there is a complete gradation up to utilities which, like gravity water supplies, have a large capital investment but comparatively little operating expense in connection with their business. For the last extreme, a percentage return on a proper base is defective chiefly in that it fails to put a premium on economy of plant construction and operation, and may even induce extravagance. For the intermediate cases the defects grow in importance as the cases are located toward the opposite end of the scale. It was long ago suggested in these columns that economy and efficiency might be induced by a periodic adjustment of rates of charge, the utility being given opportunity to profit to whatever extent it might be able from economies effected after a rate was established at the beginning of a period. Economies so made would, of course, have to be subject to adequate service, wages, maintenance, etc. Such a system would involve difficulties, but not, as we believe, sufficient to destroy its usefulness. There should, however, be even better arrangements.

It is strange that so little effort has been directed toward effecting a change in the system of computing returns and establishing the rate bases of public utilities. The returns of the utilities on the money and effort put into them have long been so low as compared with those of other business that but a poor incentive was left for their undertaking. Yet their net earnings are continually presented on the basis of a straight interest rate leading to a comparison with mortgage and loan rates instead of with other business requiring first class operating effort and rapid turnover of money.

Merchants compute their profits as percentages of selling price, or less conservatively, as percentages of cost. Manufacturers use varying systems, all of which, so far as we know, relate in some manner to business transacted and it seems highly desirable that the railways and utilities also should have their earnings reckoned on a basis involving recognition of business done as well as of capital investment or value. Such a change would do something—how much, only trial could tell—toward setting the public service corporations in a better light before the public. Save for the inertia due to court decisions referring profits entirely to "value," it should be of very great effect indeed before courts and commissions; and with proper presentation even inertia should yield to the common sense pressure of the thing within a reasonable time.

A complete plan for such a scheme as we here suggest would require a great deal of very careful work, and we have not attempted such a task. We note, however, a few salient features and tentative suggestions. First of all a utility should earn above its operating expenses, a return on its legitimate capital. For the mortgageable portion of the property—say 70 per cent—a simple bond interest rate would seem to be proper. For the remaining portion there should be a higher rate to provide for the lesser degree of security. The two might be equated to a single rate upon the entire property. This would only provide for the necessary capital, and there would have to be further provision for a profit on business transacted in order to place the utility in a class with trade and industry. The calculation of this profit may become a complicated matter, for the factors entering it include supplies, labor, management and other items operating in part on different principles and subject to different influences. How far business transacted should be analysed for this purpose we do not pretend to say. Some cases would require more detail than others. It might prove desirable in many instances to treat the matter in very simple fashion and with broad approximations. In other instances the treatment might be elaborate. But in no event should the difficulties involved be made an excuse for the complete rejection of the item as a thing essential to the correct picturing of the earnings of this class of corporations.

The rates of profit to be allowed under regulation should be such as will attract both the investment of capital and good management without providing a "soft thing" for the investors. In the determination of the profit rates there will be necessary references to many subjects such, for instance, as the rough rules of many security dealers that for first class investments, net earnings should be at least 4 times the interest charges in the case of industrial bonds, and 2 times in the case of utility bonds, the more favorable position of the utilities being due to the greater uniformity of their business.

In conclusion we state our belief that eventually there will be a broad general formula for the measurement of the profits of all classes of business. To insure generality of application, a somewhat complicated formula will be necessary, and it may be that no single business will involve all of its elements. Presumably it will involve averages and approximations, but in this respect it will merely resemble most formulas of applied science, and the approximations will constitute no objection to its use if they can be shown not to affect results beyond the requirements of reasonable usefulness. The value of such a formula as a means of comparing widely different classes of profits, would be inestimable. For one thing, it would solve at a stroke the question of what is a profiteer.

A Method of Forecasting Future Prices

To the Editor: I was greatly interested in the very able articles which you published April 7, 1920, giving one method of analyzing the fluctuations in the general price level for all commodities in this country. I was also interested in your forecast based on that analysis of the future trend of prices.

The conclusion reached by you was that prices would settle to a level of about 60 per cent above their value for 1913, and I think this prediction of yours has since been verified.

There is another method of forecasting future prices. If I can avoid being tedious and at the same time make clear the manner of applying this other method, it may be of interest to those of your readers who are students of engineering economics. I am reminded of this question by an article in your issue for March 1, page 208, being an interview with Mr. Henry S. Dennison, a forceful presentation.

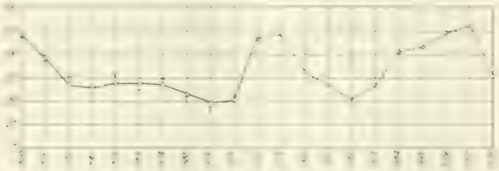


Diagram of Fluctuation of Prices of Commodities in England Since 1808

As has been said by Mr. H. G. Wells, at some place in one of his books, "the future is, in a sense, contained in the past," and if we knew all the factors that entered into the series of events, which we call "the past," those same factors projected into the future, would give us pretty accurate knowledge of the future. This, however (accurate knowledge of the future) is, of course, impossible. Not only are we unfamiliar with all the factors in the past, but we do not even know all the factors in the present. That the future cannot be predicted in its entirety from the past is shown by the very book of Mr Wells to which I have referred. It was written while the war was going on and professed to tell "what is coming," but failed to forecast the great Russian revolution.

It is, however, a temptation to try to make some kind of forecast of the future and everyone does it, with more or less success. It may be said that our knowledge of astronomy arose from the attempts of astrologers to predict future events. No scientist doubts that astronomy can today predict very accurately the position of the heavenly bodies for several years in the future.

To come now to the point, the method I refer to is to take figures representing some value in the past, for instance the general price level (the same method is applicable to any set of facts having a curve of similar kind to represent them) and from these figures find by trial, a series of sinusoidal curves the simultaneous values of which, being summated, will give each year the same, or nearly the same, value as the actual values, and then having found this series, to continue or project each member of this series of curves into the future and summate the simultaneous values in the future, which will give the forecasted value for the resultant curve. This method is, I think, quite independent of the method outlined by you in the articles which you wrote about two years ago. If it can be successfully applied, it will give further light on the question.

Two scientific methods which are independent will supplement each other and each will help to perfect the other. As illustration of this the problem may be cited which existed about 150 years ago in connection with ocean navigation. It was at that time a problem (and a very pressing and practical problem) to determine the longitude of a ship at sea accurately and speedily. There were two methods (the difficulties can best be learned in detail from an article in the report of the Smithsonian Institution for 1918), these two methods being (a) measurement of the angular distance of the moon from the fixed stars and (b) the method by the use of the chronometer. Each of these methods, as it was improved, made possible, and in fact forced, further progress in the other method. Finally the method by the chronometer became so perfect that the other method dropped out of use, but not before great progress had been made in preparing more accurate tables of the moon's motion.

To describe now the result of applying this method of sinusoidal curves to price fluctuations, take the case of average prices in England since 1800; these are given in an article in the Magazine of Wall Street. Scaling off from the curve there given values at 11 year intervals, the following series is obtained:

Year	Price index	Year	Price index
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	96
1841	[illegible]	[illegible]	102
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		

The form of the curve from which these values are taken is quite irregular, and no other kind of a curve than a summation of several periodic curves (the sinusoidal being perhaps the simplest) can be made to even approximately fit it. The sinusoidal curve is the curve of simple harmonic motion. Using a series of curves of this kind only a small number of curves, comparatively speaking, is required to give a fair degree of approximation and by increasing the number of curves any required degree of approximation can be obtained. The accompanying diagram shows the actual curve and the points on the curve calculated from the use of a series of 18 curves, these points being designated by small triangles. The agreement between them may be said to be fairly good; at least one who is partial might think so.

The dotted line indicates the trend of prices in the future and may or may not be correct. The chances are that it is not correct, since, the probability is that the curves used to represent the values in the past are not the correct ones, and even if they were it is not certain that each individual curve will continue in the future the course it had in the past, however that is the theory upon which the procedure is based.

If it is admitted that the forecast for the future may be entirely erroneous what is the advantage of such a curve compared with some other method of judging future (in any event, some judgment of the future is likely to be formed). In effect, Mr. Dennison's forecast (see March 1 Engineering and Contracting) is based on the theory that there is a major cycle and a minor cycle. As he expresses it: "Two cycles, one corresponding with the waves of the sea, the other with the broader tidal movements. Thus we have the minor cycles which have an average length of about three years, and the major cycle which seems to consist of from seven to ten years of good times and seven to ten years of less prosperous times." Mr. Dennison is talking of the cycles as shown by the sales of his company, which may be a different thing from the fluctuations in prices, though the two are somewhat closely related. But my analysis would show that there are more than 18 cycles, which must be summated to give the average price level of all commodities.

A curve prepared this way is quantitative and can be made as precise as may be desired, the values being precise, even though erroneous. A scientific man will see the value of precision, though of course accuracy would rank above precision. However, precision will reveal lack of accuracy and show where to look for the fault. In regard to the laboriousness of this method, such a curve covering 100 years, can be figured out in four hours, and if the correct values of the factors could be found, the curve would not only show that prices will be lower in the future, but also would show approximately how much lower. I do not believe that the matter is as simple as it would seem from the statement just made, but it may be that further work along this line would lead to a result of some value and certainly the enlightenment which would be reached in working with the data would be of much value.

The same method may be applied to such data as the commercial failures of the United States, figures for which are available back to 1857. These figures show "peaks" in the years 1857, 1873, 1893 and 1914, approximately 20 years apart, with secondary peaks at 1861, 1878, 1896 and 1921. The figure for 1921, however, is so much in excess of anything in previous history as to show that its value was probably not to be predicted from an analysis of figures available previous to the year 1921. In other words, the theory outlined above breaks down for the year just passed. It was an "unprecedented" year.

Nashville, Tenn. JOHN WILKES, C. E.

Railroad Rehabilitation and Business Improvement

Newspaper Editorials Commenting on Need of Early Resumption of Construction by Railways

"Railroads Standing Still"

(New York Times, Fe[illegible])

One of the highest operating offic[illegible] the most conservative railways of the country [illegible] McCrea of the Pennsylvania—is quoted as saying [illegible] country's railways are "standing still" so far as the [illegible] of their facilities is concerned. Few think that [illegible] "standing still," or doubt that we are on the eve of expansion. It follows that the country is approaching [illegible] famine. Colonel McCrea even understates the case. A decline in the rate of railway expansion had begun [illegible] war, and in each of the last five years more miles [illegible] have been abandoned than miles of new route constructed. For the five years 1917-21 the railway mileage abandoned totaled 4,989 miles, nearly 2,000 miles of track being actually torn up for material.

Just now there is an excessive supply of rolling stock, but it will not last long at the recent rate or increase of traffic. For the last month reported 144,129 more cars were loaded than in 1921. If the figures are not misleading, we are nearing a car famine. Then the existing mileage will not be able to render the service it should. In 1921 fewer locomotives were built than for any year since 1897. In 1921 40,292 freight cars were built, the smallest total since the record began to be kept in 1899. The failure to replenish the supply of passenger cars is similar. Only 246 were ordered in 1921.

Unless these official figures can be challenged, Colonel McCrea's remarks are not subject to discount. Secretary Hoover's words represent the truth: "Unless we have a quick resumption of [railway] construction the whole community, agricultural, commercial and industrial, will be gasping from a strangulation caused by insufficient transportation the moment that our business activities resume."

Hoover and the Railroads

(The Cincinnati Enquirer, Feb. 2[illegible])

Within ten minutes after Herbert C. Hoover began his statement of the railroad situation at the Interstate Commerce Commission hearing the atmosphere was cleared. Long before he concluded he had dispelled the pessimism with which the situation had been shrouded by the two Directors-General under Government control. Likewise he, indirectly, lifted the camouflage with which they had cloaked the Government control administration.

They had dwelt with eloquent verbiage on the iniquities of the old railroad regime and on the storied virtues and panoplied character of Government control. They told of millions spent not merely to maintain the railroads, but, as they claimed, to return them to their owners in better condition than they had been received.

Mr. Hoover called attention to the 10,000 additional miles of roadway required, to the shortage of 4,000 locomotives and 200,000 freight cars that must be supplied to put the railroads on an even basis with the transportation requirements of the country. He stood in the present, looking into the future instead of into the past. He visioned a prosperity restored and the need of every ounce of transportation energy that could be mobilized. He put no qualification whatever upon his statement:

"Our country is more dependent upon railway transportation than any other. All others have, comparatively, greater coast lines and internal waterways."

Mr. Hoover spent no time condemning the Railroad Administration. He made no reference to the direct debt of $1,443,810,000 incurred to the nation, no reference to the $1,144,000,000 equipment bill funded but not expended, no reference to the more than $2,000,000,000 increase of operating expenses. He passed that by as he passed by the equally condemned and discountenanced regimes of 25 and 50 years ago. He said with impressive emphasis:

"I see no occasion to go [illegible] railway finances, its propriety or lack of [illegible] or its skill. That generation [illegible] Commission approaches the financial problems of the railways upon the actual value, not upon their [illegible], and I take it we are living for the future, not the past. We want transportation, and we want it with the [illegible] private initiative and clean public service."

He left the situation clarified for the Commission. The railroads are necessary to the future of the country, to the prosperity of the shipper, to the life of the producer by the distribution of his products.

The Government is not blameless any more than the old managements are blameless. The railroads must be restored to full vigor. The least the Government can do to balance its accounts is to lend its credit to rebuild what it has helped to cripple. Mr. Hoover concludes:

"The Government would not lose a cent upon the guarantee, for if the railroads of the United States cannot earn interest upon what they are asking to borrow, let us throw up our hands and prapare for a second Russia."

Railroad Rehabilitation and Returning Prosperity

(Chicago Tribune, Feb. [illegible])

Two American men of affairs discussed the proper use of our resources last week and their advice was virtually identical. Mr. George Reynolds, speaking at Los Angeles, declared that Europe does not offer us a good risk while its governments maintain large armies, refuse to balance their budgets through economy and proper taxation, and continue to inflate their currency. Compared to the opportunities of development in our own country, whose resources are unimpaired and whose fiscal and economic conditions are solid as mother rock, there is little in Europe to justify investment of good American money or the extension of our large credit resources.

At the same time the Secretary of Commerce remarks upon the current proposals for relieving our agricultural situation by granting enormous foreign credits for the purchase of our raw materials and he declares that a billion dollars expended upon our American railroads would do more to relieve our present condition than twice that amount loaned abroad.

Mr. Hoever's statement has had too little attention. It is a most timely and illuminating contribution to the discussion of our present situation. There is no more important factor in our problem than the condition of our transportation system, as to which Mr. Hoover is right in warning the country that "unless we have a quick resumption of construction the whole community—agricultural, commercial and industrial—will be gasping from a strangulation caused by insufficient transportation the moment business activities resume."

The Tribune believes this is one of the most serious phases of our situation. Mr. Hoover does well to remind us to look ahead and realize now the bearing of railroad rehabilitation upon our future economic efficiency. An adequate transportation system is essential to the prosperity of the farmer, the wage earner, the manufacturer and merchant—in short, to every individual in the land. This is a platitude, but it is not practically applied.

But there is also the immediate effect of railway reconstruction to be considered. As the Tribune has said, if we want early and accelerated revival in this country we know of nothing which will take effect quicker than to start the railroads building up their equipment and extending their facilities. Nothing will take up so much slack in our unemployment by giving work not merely on the roads but in all the many industries which supply them, and this will reflect itself at once in new purchasing power which of course will profit the farmer as well as the business world.

We do not say that the problem of foreign credits and trade is negligible. It is important to our complete restoration, but our best policy is to try to make the fullest use of our own resources and to try to start our wheels going as best we may by building up our own vast economic plant against the day when it will be needed by our expanding opportunities.

One thing is certain, that to starve the roads by premature or inordinate reductions of rates and undue restrictions is to starve the whole economic constitution of the country. It is to ignore perhaps the most direct and widespread stimulation of business activity and prepare a serious check upon our economic efficiency in time to come.

What of Railroad Construction This Year?

Extracts from Letters of Railway Officials Regarding the Outlook for 1922

Railway Construction and Business Improvement.

Unquestionably a large construction program this year would be a vital element in bringing about an improvement in general business conditions, at least the absence of such a program will be a serious handicap. The extent to which the railroads can enter upon a fairly ambitious program cannot, it seems to me, be accurately stated at this time. The year just closed was replete with difficulties. The net income was very low and considered as a whole the amount expended toward improvements small. Conditions are still unsettled. With rates and wages undetermined it is difficult to plan for the future. There are but two ways in which the railroads can get money—earnings and borrowings, and generally speaking the second is entirely dependent upon the first. It would be fine if the roads could inaugurate and carry through a substantial program of additions and betterments, but they must protect their financial situation and it would not be at all helpful should expenditures be made for improvements at the expense of adequate service to the public and maintenance of the existing plant.

Some roads are better off than others and those with the greatest ability to do so have provided for more road and equipment additions and betterments than probably is generally known. Speaking for the Illinois Central, we have pursued the policy of keeping ourselves in position to take care of the traffic needs of the territory served and to make reasonable provisions for carrying the peak load; also, our plans during the past year have been based on a return to normal business activities. In 1920 we spent approximately $19,000,000 for improvements, in 1921 approximately $27,000,000. The amount spent in 1921 was greater than any previous year except 1918.

The property is sufficiently well equipped to take care of a much larger traffic than we are likely to be called upon to handle at any time in the near future, therefore, our expenditures for improvements this year will not be so large. However, they will be substantial. Already we have placed orders for 2,000 gondola cars and 1,000 refrigerators, which will cost approximately $6,000,000, and one piece of major work arranged for is the construction of a stretch of third track and grade revision on the line in Illinois near Chicago, which will call for an expenditure of approximately $2,250,000.

C. H. MARKHAM,
President, Illinois Central R. R.

Great Northern Will Spend $13,000,000.

I am of the opinion that the greatest contribution the railroads can make, and ought to make, towards aiding the general improvement in business conditions is by using their money and credit to come back into the market for materials and to carry out as large a rehabilitation and improvement and betterment program as they can. When this depression, through which we are now passing, finally is over and the great volume of business again becomes normal, it is a serious question whether the railroads as a whole will be ready for such business, unless we begin now to improve the facilities, including equipment.

Being of this view, we are arranging on the Great Northern to carry out a relatively large betterment and improvement program in 1922, and will spend altogether probably $13,000,000. Roughly speaking one half of it will be for new equipment and betterments to existing equipment; and one-half for additions and betterments to fixed property.

The improvements to fixed property will consist of about 50 miles of second track, two new freight terminals, one new ore dock, a fairly large program of replacing temporary bridges with permanent ones, one hundred and fifty miles of automatic block signals, and our usual rail renewals and ballast renewals.

RALPH BUDD,
President, Great Northern R. R.

D., L. & W. May Electrify 30 Miles of Main Line.

This company has no large amount of work in contemplation for the current year, aside from the possible electrification of its line over the pusher grades east and west of Scranton, covering about 30 miles of our main line tracks. Whether we will undertake this or not depends to a considerable extent upon the prices we get from the contractors who are figuring on doing this work, as if their figures are too high, our people, I am quite confident, will not want to undertake the work this year, or until conditions as respects wages, prices for materials, etc., improve substantially.

Owing to the uncertainty of what we will do in this regard during the current year, I do not think it best to give out any figures as to our probable expenditure as they might prove very misleading.

W. H. TRUESDALE,
President, Delaware, Lackawanna & Western R. R.

Lehigh Valley Carrying Out Large Terminal Job.

The only important construction work the Lehigh Valley has in mind is now in progress in connection with the building of its new Claremont Terminal at Jersey City, N. J.

This development, the first unit of which probably will be completed by Sept. 1st, is an ocean and rail terminal located directly on New York Bay. Over 400 acres of land under water already have been filled in in connection with this work and more than 4,000,000 cu. yd. of material have been dredged for a distance of two miles in the construction of a deep water channel from 250 to 300 ft. wide.

A modern wharf, 3,540 ft. in length, has been completed. In its construction some 18,500 piles, 3,000,000 ft. BM of timber, 400 tons of hardware, 22,000 cu. yd. of cement and 25,000 tons of rip-rap stone were used.

The largest ships afloat can be berthed at this wharf. On the outer end two ore unloaders, one of 15-ton capacity and the other of 5-ton capacity, have been placed for the handling of iron ore direct from ships to cars and necessary yards for the handling of the equipment are under construction. With these facilities a 20,000-ton ship can easily be unloaded in 24 hours. At this rate, assuming that it was all bulk material and carried in large ships, this equipment could handle 25 per cent of all the foreign tonnage in and out of the Port of New York.

At the land end of the dock erection will soon be begun of a traveling gantry crane of 30-ton capacity capable of handling about 100 cars of heavy rough freight each day to and from vessels as desired. The portion of the dock served by the crane is 1,000 feet long carrying track with a capacity of 190 cars.

Between the open dock and the ore dock a two-story warehouse, nearly 1,000 ft. long and 100 ft. wide, capable of holding about 500 cars of freight, is soon to be constructed. The face of the dock at this point will be provided with a 20-ton traveling crane to handle freight from the warehouse to cars to the vessels, or vice versa.

This is only the first unit of the terminal we have in mind. The Lehigh Valley has a total of 623 acres available at this point, and the general plan for the development provides for two other piers which, when completed, will give the terminal a bulkhead space of approximately 5½ miles with berthing space for 32 ships of the size of the Leviathan.

E. E. LOOMIS,
President, Lehigh Valley R. R.

Tennessee Central Will Make Considerable Amount of Improvements.

I am unable at this time to give you accurately just what improvements will be made during the current year on the Tennessee Central Ry., however, we contemplate doing the following:

1. Lay 45 miles 80 lb. rail for renewals.
2. Install three Cooper E50 steel bridges at a cost of about $50,000.
3. Purchase of new locomotives about $300,000.
4. Purchase of new equipment (coal cars), about $400,000.
5. Purchase of new shop machinery tools, about $75,000.
6. Water and fuel stations, about $50,000.
7. Other additions and betterments under consideration, $75,000.

The Tennessee Central has recently been reorganized and the new owners expect to make considerable improvements within the next twelve or eighteen months, but final program has not yet been worked out.

H. W. STANLEY,
President.

Bangor & Aroostook Work Mainly Maintenance and Renewals.

Our directors have just approved our budget which mainly calls for ordinary maintenance and renewals except that we will remodel and rebuild, probably with reinforced concrete, our enginehouse at Caribou, Maine, which will also involve the installation of a larger turntable.

We will also construct a new enginehouse coaling plant and station at Squa Pan, Maine.

Our total budget, including the above items, calls for an expenditure of $660,850.

PERCY R. TODD,
President, Bangor & Aroostook R. R.

Frisco Has $7,766,000 Improvement Budget.

We do not contemplate the purchase of any additional locomotives but we are figuring on purchasing eight 70 ft. all steel coaches and six 70-ft. all steel chair cars, which equipment will be used in our important through main line trains.

The rail program provides for approximately 185 miles of new 90 lb. rail and 100 miles of relay rail. The new rail is on hand or contracted for and the relay rail used will be secured from that released where heavier weight rail is laid. Our rail joints, tie plates, rail anchors, bolts and spikes are also contracted for.

On shop tools and machinery we figure on expending approximately $200,000, most of which is in the nature of machinery for maintaining equipment and consists of engine lathes, traveling cranes, steam hammers, forging furnaces, and miscellaneous mill shop machinery. The largest single item contemplated is the erection of 200 ton electric traveling crane at our West Shops, Springfield, Mo. This crane will enable us to handle our Santa Fe type locomotives much more economically than at the present.

So far as additional shop buildings are concerned, we have nothing in mind for the present year except a few minor extensions to round houses.

We propose to do considerable grade reduction at Crocker, Garnsey and St. John, Mo., where grades will be reduced for a distance of 1.62, 1.50 and 3.57 miles respectively at an estimated cost of $675,000, and we also contemplate the construction of 4.75 miles of second main track from Windsor Springs to Valley Park, Mo., which will give us double track from St. Louis to Valley Park, where our traffic is exceptionally heavy due to the number of regular freight and passenger trains and suburban trains which operate in this territory. Between Spring Hill and Paola, Kansas, a distance of 12.7 miles, we are going to construct second main line which will give us double track from Kansas City to Paola. Our traffic in this territory is exceptionally heavy due to the M. K. & T. using our track between these two points. We have already asked for bids from responsible contractors on the two pieces of double track and the three pieces of grade revision.

The above outlines briefly the major projects provided for in our 1922 budget.

J. M. KURN,
President, St. Louis-San Francisco R. R.

A $30,000,000 Budget for the Burlington.

This company is closing contracts for the purchase on account of this year's budget of approximately $15,000,000 of new freight and passenger equipment and locomotives. In addition, a further expenditure of approximately $15,000,000 on account of capital outlay is contemplated for various improvements to roadway and structures.

The principal items are the completion of a new freight house in Chicago; completion of track elevation and new passenger and freight stations in the city of Aurora, Ill.; the first unit of a new locomotive repair shop in Denver, Colo.; a normal program of additional double track; extension of automatic signal territory; enlargement of yards and terminal facilities; new power house; continuation of permanent bridge program, etc.

We feel that there is a noticeable improvement in business and that while a return of a normal volume of traffic will come gradually, it is in sight and we are making these expenditures in an effort to be ready for the business when it arrives.

H. A. HOLDEN,
President, Chicago, Burlington & Quincy R. R.

Improvements Depend on Earnings and Business Outlook.

The Minneapolis & St. Louis R. R. Co. is not at the present time contemplating any substantial program of new construction, betterments or other improvements.

What we may do later will depend entirely upon our earnings and the outlook for business.

W. H. BREMMER,
President.

Will Only Undertake Absolutely Necessary Projects.

Owing to financial and traffic conditions the Richmond, Fredericksburg & Potomac R. R. Co. has been compelled to restrict its expenditures for additions and betterments to such projects as are absolutely necessary, and therefore, the work contemplated for the year 1922 is rather limited in its scope. Briefly stated, the projects which have been authorized are as follows:

Construction of additional tracks [illegible] for perishable trains at Potomac Yard, estimated to cost	$12,[illegible]
New stock pens, Potomac Yard, estimated to cost	1,[illegible]
New switch tower and yard office, Potomac Yard	10,500
New turntable and tracks appurtenant thereto, Potomac Yard	66,60[illegible]
Necessary shop tools, Richmond	[illegible]

EPPA HUNTON, JR.,
President.

Atlantic Coast Line Will Lay New 85 Lb. Rail.

We expect to lay 25,000 tons of new 85-lb. rail—releasing rail of lighter weight, and to fill a few miles of our wooden trestle work with earth embankment during the current year. We are now contemplating no other work in the way of additions and betterments.

J. R. KENLEY,
President, Atlantic Coast Line R. R.

C., I. & W. Has Much Betterment Work and New Construction.

This company has before it a great deal of deferred maintenance, both in the roadway and in the equipment departments; also considerable betterment work and new construction which will bring our expenditures for extraordinary maintenance and "R. & E." within the next two years up to about $2,000,000, providing, of course, that ways and means be found for the necessary financing.

The approximate estimate of expenditures above mentioned is divided substantially as follows:

Road:		
Capital expenditures	[illegible]	
Maintenance	17[illegible],000	
		$[illegible]
Equipment:		
Capital expenditures	[illegible]	
Maintenance	[illegible]	
		$1,[illegible]

This company expects to realize some $530,000 in the near future in settlement of its claim against the Government. It will be observed, however, that this amount will be absorbed very rapidly and still leave a substantial amount of unfinished work that should not be delayed indefinitely. Nevertheless the final settlement anticipated will be of material assistance in getting behind us some of the most urgently necessary work; in fact, the general impetus to trade that will arise from final settlement with all of the roads, will probably make possible the financing of unfinished work that otherwise should not be undertaken.

B. A. WORTHINGTON,
President, Cincinnati, Indianapolis & Western R. R.

Nickel Plate R. R. Working on Grade Elimination at Cleveland.

Our road is continuing an extensive grade elimination job on the West Side, Cleveland; has recently ordered 300 steel frame stock cars and has authorized a budget of miscellaneous items totaling over $800,000.

C. E. DENNEY,
Vice President and General Manager, New York, Chicago & St. Louis R. R.

Gulf, Mobile & Northern Will Spend About $1,000,000.

I am herewith submitting a program of our proposed improvements for the year 1922, and the expenditures for this work:

Rebuilding 636 bad order cars	[illegible]30,000
Ballasting	[illegible]00,000
200,000 tie plates	15,000
20 miles 85 lb. rail	120,000

[illegible]

I. B. TIGRETT,
President, Gulf, Mobile & Northern R. R.

Pennsylvania Has Not Yet Adopted Construction Budget.

In connection with your request as to what the Pennsylvania System expects to do in the way of construction for the year 1922, I beg to advise that as yet no construction budget has been adopted.

For the year 1921 our expenditures for new work were confined to an absolute minimum, no formal budget having been adopted, and in view of the outlook for the year 1922 our directors have not felt that we were in a position to lay out an improvement budget, but rather that such construction work as it is felt must be performed would be taken up from time to time for decision.

W. W. ATTERBURY,
Vice-President, Pennsylvania R. R.

$46,000,000 Improvement Program for Santa Fe.

Our present plan contemplates about $10,000,000 for new equipment; $2,500,000 for new lines of railroad; $11,750,000 to complete improvements now under way upon our property, and $22,000,000 for additional improvements.

W. B. STOREY,
President, Atchison, Topeka & Santa Fe Ry. System

Improvement Expenditures Depend on Development of Next Few Months.

It is very difficult at this time to forecast what expenditures for improvements the railroads will be able to make. It will depend entirely on the developments of the next few months in the way of net earnings made by the roads. There practically has been nothing done in the way of improvements for the past five years and our greatest apprehension at the present time is that when business does return the railroads will find it extremely difficult to handle the traffic with the facilities available. I think every railroad in the country has a program of improvement that should be commenced but until our net revenues are such as to justify people to loan us money at reasonable rates of interest with which to do the work, there will not be very much of it undertaken.

This at least is the situation so far as our company is concerned and I think most of the other large railroads of the country are in very much the same position.

H. E. BYRAM,
President, Chicago, Milwaukee & St. Paul Ry.

Central of Georgia Will Complete 8 Mile Spur.

There are a great many things that we would like to do and that we properly should do but our budget has been held in suspense until business shows some improvement.

I may say, however, that we intend to complete a spur into the Cahaba Coal Field extending from McCombs, Alabama, for a distance of about eight miles. About 70 per cent of this work has been completed. We have been ordered by the Public Utilities Commission of Alabama to erect a passenger station costing approximately $50,000, at Opelika, Ala. We have ordered 500 ventilator box cars, to be delivered in the early spring.

W. A. WINBURN,
President, Central of Georgia Ry.

Louisiana Railway & Navigation Co. Planning to Start on $5,000,000 Program.

The railroads as a whole are confronted with the question of finding immense sums of money to make needed additions and improvements in order to be able to take care of the constantly increasing movement of traffic, which will begin to show as world conditions become more stabilized, and not only as that is to enable them to reduce the unit cost of operation in the future on account of the relatively high cost of material and labor, and also the expenditure of hundreds of millions of dollars is necessary to catch up with the enforced deferred maintenance. So far as this little road is concerned, we are getting ready now to start on a program which will require an expenditure of $5,000,000 or $6,000,000 spread over the next two years if we can raise the money, and we are depending, at least hoping, to receive some $400,000 or $500,000 due us from the Government to make a start on this work.

W. C. MORSE,
Vice-President, Louisiana Railway & Navigation Co.

Northwestern Ry. Waiting for More Favorable Times.

Our situation is so uncertain that to make any statement of the amount of any construction or improvements we plan to carry out would be purely a guess. We have many millions of dollars' worth of improvement work which we have been putting off a long time to get ahead with, but until times are more favorable we are obliged to defer them and confine ourselves to the things which have to be done to keep the road from deteriorating.

GEO. W. HAND,
Assistant to President
Chicago & Northwestern Ry.

Spokane International May Repair Tunnels.

The way the business outlook is at the present time this company will probably not do any new construction work this year. It is barely possible that we will be obliged to make some heavy repairs to one or two of our tunnels, but that is all.

E. S. McPHERSON,
Spokane International Ry. Vice-President

D. & H. Has Contracted for Rails of About 50 Per Cent Above Its Normal Requirements.

The decision in the New England rate case; the decision in the Grain and Hay case; the present hearing in ex parte 74 involving all other rates; the unsettled questions pending before the United States Railroad Labor Board regarding wages, and the possibility of a coal strike on April 1, make us unwilling to commit ourselves to any program for expenditure of money until a clear idea may be had of the future.

The ton mile movement in 1921 was 23.3 per cent less than in 1920 and was the greatest decline ever experienced by American railroads. It seems likely that some recovery may be had in 1922, but as yet there is nothing that will permit a reasonable forecast.

This company has contracted for steel rail of about 50 per cent above its normal requirements to overcome the neglect of the Director General of Railroads in maintaining the property during Federal control, and we will devote most of our activities in 1922 to similar work of recovery.

L. F. LOREE,
Delaware & Hudson Co. President

Changes in Retail Cost of Food in 15 Representative Cities

The U. S. Department of Labor, through the Bureau of Labor Statistics, has completed the compilations showing changes in the retail cost of food in 15 representative cities of the United States.

During the month from Jan. 15, 1922, to Feb. 15, 1922, there was a decrease in seven of the fifteen cities, as follows: In Kansas City, 4 per cent; in Little Rock, Pittsburgh, Providence and Charleston, 1 per cent; in Louisville and Jacksonville, less than five-tenths of 1 per cent. In seven cities there are the following increases: In Minneapolis and St. Paul there was an increase of 2 per cent. In Baltimore, Indianapolis, Milwaukee and St. Louis there was an increase of 1 per cent. In Detroit there was an increase of less than five-tenths of 1 per cent. In Fall River food prices remained the same during the month.

For the year period, Feb. 15, 1921, to Feb. 15, 1922, there was a decrease of 13 per cent in Charleston and Kansas City; 12 per cent in Pittsburgh; 11 per cent in Little Rock, Providence, Jacksonville and St. Louis; 10 per cent in Baltimore and Indianapolis; 9 per cent in Louisville, Milwaukee, Minneapolis and St. Paul; 8 per cent in Detroit, and 7 per cent in Fall River.

As compared with the average cost in the year 1913, the retail cost of food on Feb. 15, 1922, showed an increase of 47 per cent in Baltimore and Fall River; 46 per cent in Providence; 45 per cent in Detroit; 42 per cent in Milwaukee; 40 per cent in Minneapolis and St. Louis; 38 per cent in Pittsburgh and Jacksonville; 37 per cent in Indianapolis; 36 per cent in Kansas City; 33 per cent in Little Rock, and 31 per cent in Louisville. Prices were not obtained from St. Paul in 1913, hence no comparison for the 9-year period can be given for this city.

Diagram for Calculating Annual Cost of Cross Ties

By E. R. CARY

Professor of Railway Engineering, R[illegible] Institute

On page 149 of Engineering and Contracting of Feb. 15, 1922, are two diagrams for "Annual [illegible] Cost of Ties" which the writer thinks could be more easily used if put in the form of an alignment diagram or [illegible]. The following describes the method of making such a nomograph:

The general equation for a nomograph is

$$a u + b v - c y = 0 \qquad (1)$$

The values of u, v and y being properly [illegible] on three parallel lines or axes, a straight line will intersect the three axes at values which will satisfy the equation which expresses their relations.

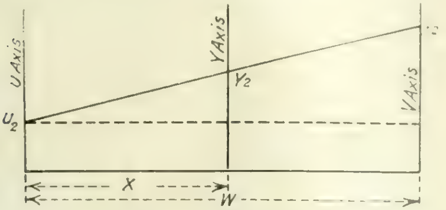


Fig. 1.

Equation (1) is true for all values of u, v and y, and is true for $u_2 = v_2 = y_2$. Then

$$a u_2 + b v_2 - c y_2 = 0 \text{ or } a + b = c \qquad (2)$$

$$\text{From Fig. 1, } \frac{x}{w} = \frac{y_2 - u_2}{v_2 - u_2}$$

$$x v_2 - x u_2 = w y_2 - w u_2$$

$$(w - x) u_2 + x v_2 - w y_2 = 0 \qquad (3)$$

Equation (3) is of the same form as equation (1).

Hence x = b and w = c.

$$\text{Then } \frac{x}{w} = \frac{b}{c}\text{, but by equation (2), } c = a + b$$

$$\text{Then } \frac{x}{w} = \frac{b}{a + b} \text{ or } x = \frac{b}{a + b} w \qquad (4)$$

By equation (2), the relations of the scales by which the values are plotted on the u, v and y axes may be found and by equation (4), the location of the y axis with respect to the u and v axis may be found.

The equation for the annual cost of a tie is

$$A = C \frac{(1 + R)^N R}{(1 + R)^N - 1}\text{, where A = annual cost per tie.}$$

C = first cost of tie in place,

R = rate of interest, and

N = life of the tie in years.

Writing this equation in the log form

$$\log A = \log C + \log \frac{(1 + R)^N R}{(1 + R)^n - 1}$$

$$\text{Let } Z = \frac{(1 + R)^N R}{(1 + R)^n - 1}.$$

Then log A = log C + log Z, or

$$\log C + \log Z - \log A = 0 \qquad (5)$$

As equation (5) is in the same form as equation (1), a nomograph may be made from it.

DATA FOR THE NOMOGRAPH

Symbols	Units	Limits	[illegible]	Scales	Axes
C	$1.00	$0.50 to $5.00	[illegible]	10	u
Z	[illegible]	5 to 100 for N	[illegible]	10	[illegible]
A	$1.00	$0.26 to $1.00	None [illegible]	[illegible]	[illegible]

The scales are the factors by which the quantities are multiplied to obtain the distances, in inches, which are laid off on the axes.

The original nomograph of which the one shown is a reduced one, was made by the use of the scales given and a distance between the axes on which the values of C and Z are plotted, of 6.6 in.

Let S = scale for log A.

Then S log A = y or log A = [illegible]

$$10 \log C = u \text{ or } \log C = \frac{u}{10}$$

$$10 \log Z = v \text{ or } \log Z = \frac{v}{10}$$

Substituting these values in [illegible]

$$\frac{u}{10} + \frac{v}{10} - \frac{y}{S} = 0$$

$$\text{Then } a = \frac{1}{10}\text{, } b = \frac{1}{10} \text{ and } c = \frac{1}{S}\text{, and}$$

$$\frac{1}{10} + \frac{1}{10} = \frac{1}{S}\text{ [illegible]}$$

By equation (4), x = [illegible] $\frac{1}{1/10 + 1/10}$ [illegible]

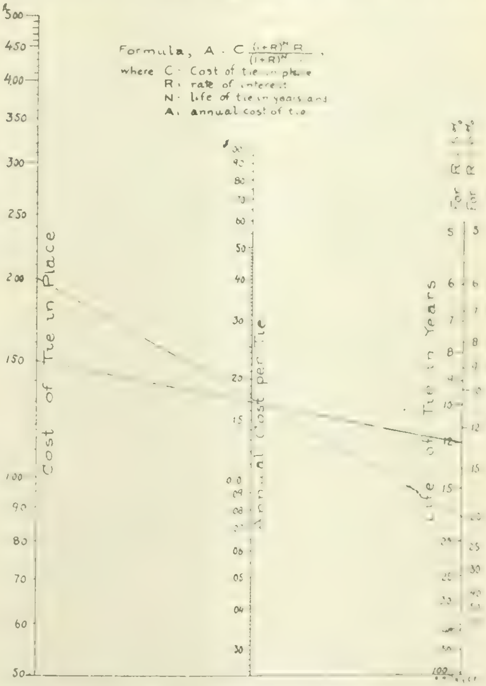


Diagram for Annual Costs of Ties

w is the distance from the C to the Z axis and x is the distance from the C to the A axis.

The nomograph is made by plotting the parallel axes at

TABLE I

N	Log. $(1 + R)^N$	Log. $\frac{R}{(1 + R)^N - 1}$	Sum.	N	Log. $(1 + R)^N$	Log. $\frac{R}{(1 + R)^N - 1}$	Sum.
5	0.1060	1.2577	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	0.1271	1.1673	[illegible]	[illegible]	[illegible]	1.1565	[illegible]
7	0.1483	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8	0.1695	1.0199	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9	[illegible]	2.9576	[illegible]	[illegible]	[illegible]	[illegible]	1.1671
10	0.2119	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	0.2543	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
25	[illegible]	2.3212	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
30	[illegible]	2.1775	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
50	[illegible]	3.6792	[illegible]	[illegible]	[illegible]	3.5371	[illegible]
100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.2490	[illegible]

these distances and plotting on them the values of C, Z and A by the use of the scales given and found

On the Z axis the values given in Table 1 were plotted and the points found were numbered with the corresponding value of N

To show the use of the diagram the following problems are solved

1 Find the annual cost of a tie that costs $1.50 in the track and whose life is estimated to be 12 years, with money at 5 per cent

Join 12 on the right axis and under "For R = 5 per cent," with 1.50 on the left axis and where the resulting line crosses the "annual cost per tie" axis, read $0.17, the result

2 Find the annual cost of a tie that costs $2.00 in the track and whose life is estimated to be 20 years, with money at 6 per cent

Join 20 on the right axis and under "For R = 6 per cent."

With 2.00 on the left axis and where the resulting line crosses the "annual cost per tie" axis, read $0.175, the result.

This diagram may be used for sinking fund problems. The annual amounts to be placed in a sinking fund whose value increases by compound interest, is found by subtracting from the amount obtained by the diagram the interest on the cost of the tie in place.

This use is shown by the following problems:

3. Find the annual amount to be placed in a sinking fund compounded at 5 per cent interest for a tie costing $1.50 in the track and estimated to last 12 years.

From $0.17, obtained in problem 1, subtract $0.075, the interest on $1.50 for one year at 5 per cent, leaving $0.095, the result.

4. Find the annual amount to be placed in a sinking fund compounded at 6 per cent interest for a tie costing $2.00 in the track and estimated to last 20 years.

From $0.175, obtained in problem 2, subtract $0.12, the interest on $2.00 for one year at 6 per cent, leaving $0.055, the result.

February Construction 73% Ahead of Last Year

February construction activity was 73 per cent greater in volume than it was in the corresponding month of last year, according to the F. W. Dodge Co. The total amount of contracts awarded last month in the 27 northeastern states of the country amounted to $177,365,000, an increase of 7 per cent over January, and the second largest February total on the Dodge Company's record.

A significant feature of the February construction record is the increase in business buildings over January. The increase in square feet of space contracted for was 30 per cent, and the increase in total cost was 65 per cent. February business buildings amounted to $39,180,000, or 22 per cent of the month's total, an unusually high percentage for this class, which was exceeded only by residential building, amounting to $75,703,000, or 43 per cent of the total. Public works and utilities took third place, amounting to $21,193,000, or 12 per cent of the total.

The accumulated volume of construction since the first of the year has been 60 per cent greater than in the first two months of last year. Contemplated new work reported in the first two months has amounted to over $800,000,000, more than double the amount of work placed under contract in the same period

Public Against Government Ownership of Railroads.—In a discussion at the recent symposium on Railroad Transportation held by the American Society of Civil Engineers, George W. Simmons, vice-president and general manager of the Simmons Hardware Co., St. Louis, stated that they had recently taken a poll from about 500 salesmen, whose reports in the past on such matters have been proven practically 100 per cent accurate. The reports show that the only sentiment favoring Government ownership is among railroad employes and organized labor, and among those who believe in socialism. A few scattering reports indicate that some farmers are almost willing to try Government ownership as a means of lowering rates on farm products. In almost all sections, however, there remains a recollection of Government operation and almost universally the sentiment is "never again."

The Motor Truck As An Asset to Railroad Operation

Conditions Under Which Motor Truck Operations Can be Substituted for Railroad Operation Outlined in Am. Soc. C. E. Symposium

By R. S. PARSONS,
General Manager, Erie R. R.

The motor truck has demonstrated its ability, as a mechanical device, to move freight promptly and efficiently. Consequently, railroad managements must accept the inevitable and meet the motor truck as an ally rather than as an enemy. Inasmuch as a benign public has seen fit to provide the right of way, roadbed and track for this means of transportation, it is the duty of the far-seeing railroad manager to welcome it as an aid and not condemn it as a competitor.

Some of the conditions under which motor-truck operation can be substituted for present-day railroad operation are:

1. Short branch-line operation.
2. Trap car service.
3. Suburban distribution.
4. Utilization of outlying yards in lieu of yards in congested districts.
5. Terminal distribution.

Short Branch-Line Operation.—Branch lines of light traffic are unprofitable. Motor trucks, on improved roads, can be substituted for both passenger and freight service and the railroad lines can be abandoned. If improved roads do not exist, the right of way and roadbed of the branch line can be turned over to the proper authorities for the construction of a highway. An instance of the use of this arrangement may be found in the utilization of a part of the abandoned Delaware, Lackawanna & Western R. R. roadbed by the Pennsylvania Highway Commission for the state road between Binghamton, N. Y., and Scranton, Pa.

Trap Car Service.—In industrial centers, many industries produce freight for diversified points. This freight must be assembled at some central station and consolidated for various destinations. The movement of the cars of freight for miscellaneous points, between the industry and transfer platform, is known as trap car service. It is usually performed through congested yards, and in order to render proper service must be performed on specified schedule. This renders the service expensive and the cars used in this manner take up unnecessary room in the yards to the detriment of through service. This trap car service can be performed by motor trucks much more cheaply than by the use of cars. The result is an expedited movement with real economy, a saving of equipment, and relief of congested yards to the advantage of carload outbound freight and inbound raw materials.

Suburban Distribution.—Every large city becomes surrounded by a suburban area of more or less intensive development. The use of the expensive terminals of the railroads for local distribution throughout these areas results in an economic loss and requires the development of much larger terminals than would otherwise be necessary if such local distribution were eliminated. Freight for local distribution cannot be refused, however, as such action would affect the solicitation of profitable long-haul business. Terminal costs more than absorb the entire freight rate on local distribution of this character. Motor-truck distribution through suburban areas, within a radius of from 30 to 50 miles (depending on the condition of the roads), is more satisfactory and economical than similar distribution through the medium of city freighthouses and way freights. This method of distribution in the New York suburban area should be cultivated by all railroads.

Utilization of Outlying Yards in Lieu of Yards in Congested Districts.—In rare instances, railroad managements have been far-sighted enough to anticipate the growth of cities and to prepare adequate yard room to accommodate the increase in business. Where this has not been done, it results in later years in the necessity of purchasing areas at great additional costs and under disadvantageous circumstances. The growth of a city compels much additional expense on account of the elimination of grade crossings and diversion of highways, also municipal ordinances against smoke, noise, and the blocking of crossings, make the operation of internal yards extremely expensive. The elimination of such yards; the selling of the valuable property released thereby; the use of funds so acquired in the construction of more properly designed yards outside the city limits, together with the institution of motor-truck service to interior stations, would undoubtedly prove economical in many instances.

Authorities agree that the proper measure of cost of operating motor trucks is the cost per day rather than the cost per mile. As the daily mileage increases the cost per mile will decrease. There are so many items of this expense that are not absolutely dependent on the mileage made, that an additional mile—or even two—between outlying yards and city freight houses will not increase the cost of trucking service proportionately.

Terminal Distribution. The growing opposition to grade crossings and the expense of eliminating them; the increase in municipal and state taxes; and the enormous cost of real estate, render the building of industrial tracks in the heart of great business centers impossible. Here, the motor truck becomes a necessary aid in combating undue terminal charges.

In St. Louis, Mo., with its population of nearly 800,000 people, practically all the railroads terminate their freight activities at East St. Louis, and all carload and less than carload freight, where there is no direct connection with an individual industry, is contracted by a trucking corporation which provides inland stations and delivers carload freight and truck freight from East St. Louis across the bridge to St. Louis.

The tractor and trailer system which is used at this point, delivers carload and less than carload freight between the railroad and the consignee on inbound and outbound freight. This system takes up the lost motion on the motor unit, three trailers being provided for each tractor. The haul at this point averages about 2 miles, and the tractor with its three trailers can handle about 45 tons of freight per day, at a cost of about 70 cents per ton.

As a demonstration of the economy of this method, it might be cited that only a short time ago the Pennsylvania R. R., with an all-rail line connection in St. Louis, diverted its freight to this tractor-trailer method of distribution.

In Cincinnati, O., the demountable body, or container, is used, the operation being confined to the transferring of less than carload freight from one railroad to another. The demountable body has the same advantage as the tractor-trailer in allowing the motor to continue in operation while the loading and unloading takes place. Hoists, at loading and unloading points, quickly remove the container from the truck chassis. The average haul is about 1½ miles and the cost is about 51 cents per ton.

The New York City Plan of the Erie R. R.—In New York City, a radical departure is being made at the present time in terminal distribution of inbound freight and the collecting of outbound freight. Under a contract with the United States Trucking Corporation, the Erie R. R. delivers its cars to the trucking company in its yards on the New Jersey shore. The freight is loaded on trucks and ferried to New York City, utilizing the ferries, in so far as possible, at times other than during peak loading. A common rate is paid on all freight trucked to an imaginary point in West St. From this imaginary point, freight is distributed: First, to piers for steamship loading; second, to inland freight stations; and third, for store door delivery. Different additional rates are allowed for these three methods of distribution. In the case of steamship delivery, freight is unloaded on docks the same as any city freight that may be so handled.

In the second instance, inland freighthouses have been developed by utilizing ground floors of warehouses, owned by the Independent Warehouse Company, at Beach, Greenwich, Leroy and Montgomery Sts. Through an arrangement with the warehouse company, freight may be floored for immediate delivery to the consignee or may be elevated into warehouses at the consignee's request for subsequent delivery. These inland stations are in every respect railroad stations.

The third method of delivery is worked out between the trucking company and the consignee, the latter preferring, in many instances, to receive his freight from the trucking company rather than have it go through the inland stations. This reduces the cost of handling freight both to the trucking company and consignee and expedites delivery. True economy, however, cannot be reached in this work until specially constructed trucks of either the "container" or "trailer" type have been placed in the service.

With the completion of the vehicular tunnel and the elimination of the ferry service with its resultant delays, this method of delivering freight to New York City will meet with increasing favor. It is a well advertised fact that it costs as much to move a carload of freight from the railroad yards in New Jersey and deliver it in New York as it does to move the same car of freight from the same yards to Buffalo, N. Y., or Pittsburgh, Pa. Any method, therefore, which reduces this large expense (which is principally in the maintenance, operation and repair of lighters, tugs and docks), will be welcomed.

There has been a noticeable shortage of steamship pier space on the North River for some years due to the fact that 30 per cent of all the piers are being used by New Jersey railroads for the purpose of delivering freight to New York City. Through the trucking method of delivery a large proportion of these piers will be released and can again be used for steamship purposes. It is a pity that this proposition had not been worked out before the steamship piers on Staten Island were built, as the burdens which will be imposed on the railroads for a long time to come through lightering to this distant point, will be a marked reflection against the economical operation of the port.

The $200,000,000 Port Development Project. The New York-New Jersey Port and Harbor Development Commission contemplates the construction of vast assembling yards on the New Jersey meadows, where cars from all railroads will be assembled; extensive transfer stations, where freight will be taken from cars and loaded in containers for transfer to tunnels; an extensive tunnel system, where small cars automatically and electrically operated will transport this freight to points underground in New York City for further handling and distribution; and warehouses and freight stations in New York City to facilitate this distribution.

In this construction more than $200,000,000 must be spent and when it is in operation, any freight so handled, after it has reached the city, must ultimately depend on the motor truck to reach its destination, the only exception being where the receiver of freight is fortunate enough to be located adjacent to one of the terminal stations.

With the vehicular tunnel from Canal St., New York City to Jersey City in operation, freight may be loaded directly from cars in New Jersey to motor trucks and without further re-handling be distributed directly where required by the receiver.

Except for the North River, the port development plan would not meet with a moment's consideration. Let us, therefore, undertake to eliminate the North River by the construction of a series of tunnels, at a cost much less than the port plan.

First. Build a tunnel from Lower New York to a point adjacent to the existing freight yards of the Jersey Central, Lehigh Valley, and Pennsylvania Railroads.

Second. The new vehicular tunnel, now under construction, between Canal St. and a point adjacent to the yards of the Erie and Lackawanna Railroads, will take care of freight unloaded at these points.

Third. Build a tunnel from a point near 50th St. to a point adjacent to the West Shore Tunnel, for the handling of the business of the West Shore.

Fourth. Build a tunnel from 125th St. to a point adjacent to the freight yards in the vicinity of Fort Lee Ferry.

Fifth. Build a belt line along the Hackensack River to the New Jersey Meadows, connecting with all the railroads mentioned. At the present time, tracks are available for about half this distance. Over this belt line, freight consigned to New York City could be moved to the most adaptable yard, unloaded at existing team tracks, and trucked directly to point of destination, eliminating any north and south trucking in New York City.

This plan, as outlined, would cost much less than the plan under consideration and would give relief to the entire city instead of to a small part of it, and, in addition, would expedite the movement of pleasure vehicles in and out of the city. Trucking of this nature would not add to the congestion of New York City streets as the same freight is now trucked between warehouses, ferries and the pier railroad stations.

Method of Driving the 73 Ft. Wide, 50 Ft. High Rove Barge Canal Tunnel

One of the most interesting construction jobs now under way in Europe is the driving of the Rove tunnel, a link in the barge canal connecting the Rhone to the harbor of Marseilles, France. This canal will allow without any transhipment the traffic of barges of 1,200 to 2,000 tons. The Rove tunnel is 73 ft. wide and 50 ft. high and about 8,000 yd. long. The water-canal part is 60 ft. wide, 13 ft. deep and is bordered by two tow-paths 7 ft. wide at a level 5 ft. above sea-level. Every 300 ft. a sheltering nook is provided, thus enlarging the canal width and bigger chambers are arranged about every 1,200 yd.

Entrance to Underground Workings as Seen from the Interior.

The dimensions of this tunnel render it one of the largest works of its kind yet achieved. Its section of over 3,250 sq. ft. is about six times bigger than a double-track railway tunnel. The total volume of excavation required is about 3,000,000 cu. yd. We are indebted to the February Compressed Air Magazine for the following particulars regarding the construction methods on this tunnel.

Method of Working. The start was made in April, 1911, by the sea-shore end.

Two galleries, each about 90 sq. ft. in section were driven at the base of the tunnel; the lower level of these galleries was at the level of the tow-paths, i. e.: five feet above sea-level. The gallery on the right-hand was driven first, the left one following it. These two galleries were connected by a series of short galleries at an angle of about 40 degrees with the central line of the tunnel, thus helping the ventilation of the tunnel and the hauling out of the cuttings.

From the top of these side galleries, inclined shafts were sunk every 60 ft., these shafts ending on each side of the top gallery (section 3). The top gallery (level 33 ft. above sea-level) as driven had a small area (40 sq. ft.) and the cuttings coming from this gallery were thrown with shovels in the side-paths, therefore facilitating the loading of the muck-cars in the lower gallery.

The top gallery was later on enlarged (section 4), and its lower level excavated down to the level twenty feet above sea-level (section 5). At the end, the side excavations were achieved.

According to the nature of the ground, timber-work was used, in certain parts it being possible to make an excavation of 72 ft. in diameter without any support. In others, where the formation was softer (aptian marl) a very heavy wood-work was necessary, and the driving work had to be conducted with the greatest care.

The side-wall of the lower gallery from the floor level up to the height of about seven feet was made in advance in order to be ready to support the upper arch which was built of steel frames of high resistance for holding the heavy stone-work. The lining was made in 20 ft. sections. The arrangement giving the fastest speed with the maximum of safety was as follows:

Every 60 ft. or every third section, one section was under work (driving, placing the forms or masonry, etc.). The next section was never worked before the complete setting and the taking off of the forms from the finished section. An idea of the progress of the work is given by the various sections of the tunnel shown in the accompanying illustrations, these sections being about 175 ft. apart. The driving work, if necessary, was made at the same time on three sections. This gives a total length of 1,700 to 2,000 ft. of tunnel under work.

Drilling, Ventilation, Illumination.—The drilling work has been done exclusively with Ingersoll-Rand jackhamers. Compressed air, at a pressure of 150 lb., was furnished from the compressor-plants at each side of the tunnel, by 7-in. pipe leading up to and immediately behind the heading.

This system of drilling made possible a rate of advance of 5 to 6 ft. per 8 hours shift. It was useless to hurry the driving of the first galleries as was the custom in other tunnels, as the enormous amount of muck to be taken out of the tunnel was limiting the daily advance about 14 ft. of finished tunnel.

The ventilation was obtained by means of a 22-in. vent-pipe laid in the right-hand gallery, and in which the powerful fans were blowing the fresh air wanted.

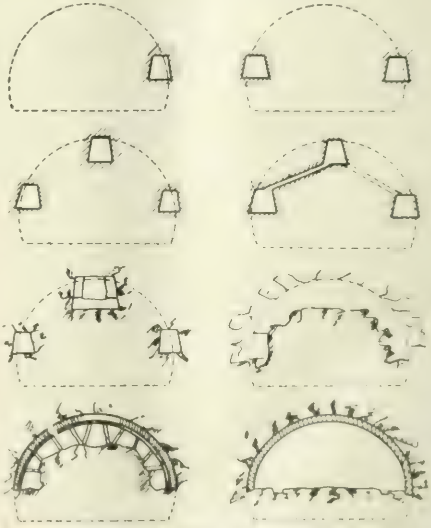
In 1913, when the Logis Neuf shaft was met, another fan was put on top of the shaft (500 ft. deep); this fan was blowing 17 cu. yd. per second, corresponding to 2.6 cu. yd. per man per minute, and 125 cu. yd. per lb. of dynamite exploded. Supplementary ventilation was provided by the exhaust air from the working of the pneumatic tools and the locomotives.

The illumination of the work was obtained by individual portable carbide lamps; the cranes fitted with electric lights and the locomotives with acetylene search-lights. When the stross is entirely taken off, the track is illuminated by 200-candle electric bulbs, and the station by powerful lamps.

Haulage and Disposal of Muck.—The muck is at the present time being hauled outside the tunnel on a 30-in. track by mechanical haulage. The type of muck-cars in use has been designed by the contractors. These cars have a capacity of 4 cu. yd., are mounted on a heavy frame, and are of the dumping type.

At the heading the muck is shoveled on a low platform car and later on loaded in the dump-cars. The debris of the top gallery and of the sides falls by the action of gravity through vertical shafts leading to the top of the lower galleries. The muck shoveled by hand is received there in the cars which were pushed under the shaft in a convenient position.

Behind, in the stross, the loading is made partly by hand and the remainder by compressed air cranes. The cars are hauled by means of compressed air locomotives. These locomotives of 150 to 200 H.P. have been designed for passing in the smaller sections of the galleries, and their weight is sufficient for hauling 200 ton trains. They are of two types: one of the H. K. Porter Co., Pittsburg, the other one built in France and designed by Leon Chagnaud, the contractor for the tunnel. These locomotives are both of the compound type and haul generally trains of 35 to 40 loaded cars.



Plan of Driving Pilot Headings and Method of Widening.

Compressed air, under a pressure of 1,400 lb. for loading the locomotive tanks, is carried along the tunnel by a special pipe and provided with a loading station every 550 yd.

An important clearing station has been reserved at each entry of the tunnel, and the main track entering the tunnel follows the left-hand gallery. From time to time, the main track is connected to the right-hand gallery by side tracks for helping the traffic.

At about 4,500 yd. from the entry, a station has been installed at 3/1000 slope alongside the stross. This track leads to the point + 26 ft. and is used for supplying the lumber and the stross for masonry work. These materials are passed downwards for the main part of the lining, and elevated by the men for the upper part of the quay work.

At each entry the muck trains are hauled away by compressed air locomotives of about 250 H. P.

The compact limestone is brought to a crushing plant, which furnishes all the broken stone and the crushed sand used for the masonry work. The remainder of the muck has been used for the dams for filling the space behind the quay walls and for the new "President Wilson Dock" at the south. At the north entry near the Etang de Bolmon, it was used for building up industrial land along the lake

With average conditions of work the amount of muck hauled outside the tunnel reached, for both entries, 1,350 cu. yd. per day.

Drainage.—The formation encountered was mainly of compact limestone or marl and clay limestone. In many points this limestone let water flow in the tunnel; several springs have also been found, having an output reaching 525 cu. yd. per hour in the dry season and in winter 2,700 cu. yd. per hour.

It has been very difficult to drain this amount of water on a horizontal distance of 9,000 yd. Steel or concrete drain pipes have been used, and several pumping stations inside the tunnel were found necessary for pumping water from one station to the other. At the Ste. Maxime shaft a multicellular centrifugal pump had to be installed, raising water 230 ft. high. The total power required by the pumps reached some times 400 H. P. In 1913 a big crack in the limestone formation let over 800 cu. yd. of water flow in the tunnel. A considerable amount of grouting work was necessary for filling this crack.

The Tunnel Lining.—The type of lining varies according to the nature of the formation met and the design of the side-paths.

In solid formations the lining has a thickness of 28 in. to 40 in. The side walls are laid on the natural ground. The bottom of the canal will receive a lining of 24 in. thick. In the marl limestone, more or less brittle, the lining reaches a thickness of 40 in. to 50 in. The side walls are in this case supported by an important foundation four feet thick.

The arch is built in 20 ft. sections without any connection with the next section. The masonry work is made with hard limestone blocks coming from big quarries which were opened by the contractors at Cassis and Marignane.

The sand was crushed from the material coming from the tunnel, and the mortar was made of an excellent quality of hydraulic lime.

Behind the stross the digging of the canal was started. The muck was loaded by hand into buckets, which were elevated by electric cranes and unloaded into dump-cars at the level + 5 ft. Every 550 yd. a down slope of 3/1000 permits the placing of a track running down to the level—14 ft. Thus the muck coming from the lower part of the cut is quickly hauled to the upper level.

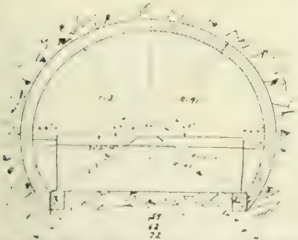
The motive power was supplied by the Compagnie d'Electricité de Marseille; for the south entry three phase current, 5,000 volts, 50 cycles being available.

The compressing plant included three two-stage air compressors, working at a pressure of [illegible] lb. for the haulage plant, and three compound air compressors at 1[illegible] lb. needed for the drilling. These compressors were actuated by 500 volt motors of more than 2,000 total horse power. Several of these compressors of 500 H. P. were supplied by the Ingersoll-Rand Co.

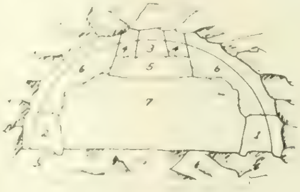
The high voltage current was reduced in the tunnel by transforming stations every 1,100 yd. A primary voltage of 5,000 volts was reduced to 190-110 volts for the cranes, pumps and electric lights.

A locomotive repair shop, forge shop, etc., where more than 250 workmen were employed completed the working equipment

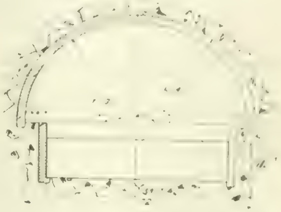
Big lime stores were arranged which could hold a capacity sufficient for three months work.



The Heavier Type of Tunnel Construction.



Underground Excavation Plan.



Section With Light Construction Lining

A similar plant layout was provided at the north entry at Marignane, where the electric current was delivered at 1,300 volts by the Energie Electrique du Littoral Mediterranean, and reduced to 440 volts, 25 cycles.

During the war, 1914-18, the work had been progressing, but at a reduced rate, owing to the lack of help and of raw material.

The headings came together on Feb. 18th, 1916, thus helping the natural ventilation of the tunnel and facilitating the management by the direct communication between the two ends.

Since the end of the war the number of men reached a total of 1,200, working in three 8-hour shifts.

Replacing Derailed Cars by Means of Pulling Rope and Frogs

Breaking in or pounding down a new track over fresh fills and a soft roadbed with modern big equipment is conducive to numerous "spills." If one is trying to keep a 300-ton shovel busy digging earth at the same time, something speedy is needed as a re-railing aid. A method of using a pulling rope in conjunction with a re-railing frog, devised by George Leibig, pit foreman for the Cornwall Ore Bank Co., of Cornwall, Pa., is described as follows in a recent issue of the Engineering and Mining Journal:

The rope may be cut from old hoisting rope and should be about 1¼ in. in diameter and 25 ft. long. Tie or clamp one end of the rope to a hook and the other to a coupling link. If tied, the first pull of the locomotive will make a never-slip knot. It is also easier and quicker to re-tie the rope than to change cable clamps if a tear occurs.

The section ahead of a derailed truck is uncoupled and the link end of the rope attached to this. The hook is caught in the truck frame back of the journal box on the side which will draw the wheels to the track. After the wheels are pulled close to the rails, the replacing frogs are used along with the rope. The side pull of the rope on the truck crowds the wheels to the rails and counteracts the overturning effect of a loaded car on the frogs.

Warped "A" frogs can be used and need not be blocked up or fastened to the ties. With trucks askew of the track on an extra hard pull, a second engine to shove may avoid a possible tear in the rope, and save time. Nearly any derailed car can be quickly replaced without unloading and with little damage to the track. Where a piece of track is giving trouble, the ropes are carried on the locomotives, and only fifteen or twenty minutes are required as a rule for jobs that formerly took one-half hour to three hours.

The Relation of the Engineer to Railroad Operation

Paper Presented at Last Annual Meeting of the Iowa Engineering Society

By R. J. SMITH

The engineer's work-a-day function throughout the railroad organization runs in such a groove that he is apt to overlook his essential relations with the other features of operation. It may seem trite to say that railroads exist to run trains—preferably at a profit, yet the engineer at times seems to regard his construction or maintenance as the prime activity of all concerned. In his technical isolation he is sometimes prone to forget that train operation is the great object in all railroading. An addition to the cost of construction in order to facilitate movements of the operating department, is often resented by the engineer as an inexcusable imposition upon his activities, and this resentment, of course, is returned in good measure by the untutored operating department, which, in its turn, cares not a hang for construction costs, with the net result that there is frequently friction and antipathy that waste real money. The purpose of these remarks is to remind the engineer that after all, and regardless of the magnitude of his own particular work, operation of trains is the great activity of railroading to which all else must be subordinate. Our true guide must be the efficiency of train operation, and we must each have in mind the total cost to the railroad, and not solely the cost of any of the individual enterprises involved. Let us review briefly the engineer's place in railroad activities.

The Engineer's Part in Construction and Maintenance.—First we have the original construction, which must be so speeded that operation may be started at the earliest moment in order to bring in revenue. Here the engineer is paramount and must have constantly in view the aims of the management in placing certain stretches in operating commission. Then follows, for all time, the maintenance of way. Here the engineer, while still important, sinks to a subordinate place. Under these two chief heads of construction and maintenance most of the engineer's activity will always fall, but he follows many ramifications of these major interests and becomes involved in land matters, various kinds of contracts and in other legal phases, such as damage cases and the like.

Cost accounting and valuation constitute a field in themselves which may remove the engineer very far from any actual building or operation as he has ordinarily thought of them. Later construction and maintenance refinements may bring the engineer to specialization in large projects, such as terminals, track elevation, electrification. The greater part of these activities require the engineer to be in close touch with train operation, and his adequate grasp of the methods and problems of that operation is of the greatest value to him in his immediate work.

The highly technical activities, such as bridge and terminal design, may lead to a specialization that, for the engineer of good average ability, may so engross him that he narrows his groove and to that extent follows a course apart from the larger game of operation as a whole. If his work is of a more general character, so that he is brought to many different points of contact with the operation of trains, he will be led to diversity of interests and will require, and acquire, an ever broadening knowledge of other phases of railroading.

The railroad business must have its highly technical engineers, its specialists who focus upon one branch to the exclusion, perhaps, of all else. Generally, these men are unusually well fitted by temperament, and perhaps by the accident of some special training in their earlier experience, to follow one line only, and they would perhaps be disturbed and even unhappy and inefficient in a diversity of engineering work. Most of us, however, without the gift of unusual ability in any one line, can find a larger interest in the railroad game as a whole and in that attitude are free to study that game as it is being played all of the time around us. Since this is the type that the majority of us belong to, we shall, as a general thing, be greatly mistaken if we do not pursue that study constantly in connection with our immediate duties, for such study will surely develop us and eventually lead to greater service and compensation.

The Engineer Should Study Operation. Thus, the rank and file of railroad engineers should familiarize themselves roughly with the book of rules, the dispatcher's commoner orders, the capacity of sidings and of the several classes of locomotives, particularly of any work train power that they may employ, the time-table, the wage scales, the engine stages, with the peculiarities of lay-out and operation of terminals, and with the organization and its personnel. Of course, if such an engineer were running about over several divisions he could not do all of this with accuracy, but in the numerous cases where a man works one division for a long time he can acquire an amazing store of sound information and have a bully good time doing it. His knowledge of grades and alignment will probably be more precise than that possessed by anyone else.

Such information as that indicated above enables the engineer to co-operate with the operating department to save it delays and overtime and in return to benefit his own work by securing more prompt service at minimum cost. In the course of a season's work an engineer may save thousands of dollars in work train service alone by planning his plant and material movements in the light of the time-table and other operating requirements. The suitable location of grades and the entrance turnouts in pits may be worked out to much the best advantage only when the engineer understands the train and shovel movements and is in complete accord with the operating department.

In the lesser matters too, it pays a chap to study operation. Knowledge of the usual baggage movements may enable him to get his speeder handled promptly and carefully when otherwise it might be overlooked or broken in transit. Familiarity with operating details of his division often enables him, particularly on mountain roads, to win the dispatcher's regard, so that he is greatly helped in getting over the line on his gas-car. Intelligence in requesting special train stops seldom goes unappreciated by the train service, so that in real necessity some special accommodation can be secured. Examples might be multiplied.

Further, we should keep in mind that there is little in the realm of railroading that is not susceptible of improvement through the analytic methods of the engineer, if only he has the knowledge. His intensive study of practically any branch of operation should lead him to some betterment. The field is wide.

Co-operation with the Operating Department.—Recall, if you will, that in the above paragraphs mention was made of "organization and its personnel" and that a little later the words "accord" and "regard" were used. These references bring to attention that very important item in the engineer's relations to the operating department, co-operation.

We hear the word so incessantly that it perhaps becomes tiresome, but it means so much in the business world that we must bear with it, and more, study it. Only by knowing substantially the scheme of organization of his road and, to a considerable extent, the characteristics of those individuals who go to make up that organization, can the engineer carry out his work with the greatest efficiency. A chart of organization would hardly suffice. Titles are often misleading, and the engineer, whatever his station, should be keen to discover what men really are in their temperaments and abilities, what they are supposed to do and what they actually accomplish. When the opportunity presents itself to observe one of these men in action the engineer should embrace it with interest in order to get a line upon the other's problems and the methods he uses to meet them. In this way his understanding of the difficulties of the other fellow's job will expand, he can get something of their viewpoint, and will thus be better able to cope with them if they impose upon him and to co-operate with them if there is any chance at all presented.

As illustrations, the engineer who understands something of the train-master's practice can get far more from his work train crew than would otherwise be the case; he who knows the road-master's ups-and-downs will get maximum results in the gravel pit or at a slide; while the engineer who knows what the yardmaster is up against will very likely get his outfit train through the terminal with greatest expedition. Back of all this understanding of the other fellow's difficulties must lie a real desire to help him, and the cultivation of acquaintance and even friendship through square dealing.

toleration and good work is of prime value in getting one's own job well done. This is not intended as a preachment, but I am convinced, and feel strongly tempted to say, that nowhere is the golden rule more productive than in a great railway organization.

High Quality of Work As a Means for Securing Co-operation.—A signal aid to the engineer in enlisting co-operation can always be had in performing a high quality of work. Sometimes this work may be of a spectacular nature which will excite the admiration of men, and even though that particular performance may not be difficult there is no harm on rare occasions in "playing it up" a little. I have in mind an instance of this that I once witnessed and with your indulgence will relate as briefly as possible. A location party in mountainous country had worked several days on a short piece of preliminary, only to discover that the line would have to be abandoned because of the excessive yardage of a tunnel, with the only alternative an immense slope of slide rock. Reconnoissance had banked upon a shorter tunnel. The work had been very arduous on this winter job in a box canyon, and the unusually large party which had rough characters in the persons of its axmen and teamsters, became thoroughly disgruntled over what they regarded as sheer waste and inefficiency. The line was changed to cross a formidable cleft made by a mountain river, which it was impossible to chain. Because of the difficult alignment that was sure to be encountered in this crossing, it was decided to locate then and there, with the result that sharp curvature with difficult spiraling was encountered in the crossing. The simpler triangulation would not avail, so that the problem appeared to all but two of the party as impossible of exact solution. Actually, while some very nice calculation was necessary, the topography upon the edges of the gorge was exceptionally favorable so that when the line was taken up upon the other side, after a wide detour had been made, the curves checked out with a gratifying accuracy that enabled the party to proceed with only slight delay. This feat so aroused the admiration and enthusiasm of the entire party that the effect was noticeable for days, and the engineer, who himself realized that he had frequently done much more difficult things on that same piece of location, was nevertheless slow to dispel the illusion that practically all of the party labored under.

In general, of course, consistently reliable work upon the part of the engineer is what will count in the long run. Often he is associated with some other department that depends for its success in making a good showing upon the dependability of the engineer's performance. This is illustrated in the case of a railroad which erects its own bridges, for the erecting superintendent can be greatly hampered by comparatively coarse work on the part of the engineer who, however, has not let any actual error creep in. In such work extreme accuracy in setting the steel-lines upon masonry for the reception of pedestals in heavy bridge work is greatly appreciated by the erectors, and they seldom fail to reciprocate very handsomely in some way or other. Our ethics require us to hold good work as an essential that is its own reward, but it is just as well to point out that additional and more material rewards are apt to follow in bettering the engineer's relation with other departments and particularly with the operating department.

One Method of Securing Co-operation from Construction Crew.—In securing co-operation a good general rule is to remove all mystery from your performance as an engineer and, where possible, to base your conclusions upon common sense and the obvious. A locomotive engineer who disregards a bridge slow-order may be hailed before the superintendent and coerced, but he may also become an enemy in the process. How much better this was handled in the following case which comes to mind. A work train engineer on a line not yet open to operation persisted in running a false-work slow-order much too fast and regarded the "feel" of the bridge as just a little extra "timber-spring." Instead of reporting him the engineer in charge invited him to let his fireman run for water while he himself went "under" to see how the work was going on. By one device and another the locomotive engineer was detained beneath the bridge until the fireman returned for his string of cars and, following the example of his superior, hit the bridge at a good 25 miles per hour in spite of a 4-mile order. When the timbers sagged very noticeably upon the blocking and the dirt rattled down from some of the foot-blocks in the dump our "hog-head" was convinced and never again questioned the engineer's judgment. Such a remedy could not often be applied, but it illustrates a very good method.

While this appreciation of the points of view, and this co-operation with the activities of other men and departments are both of the utmost value to the engineer in his professional capacity, they become vital should he have in mind entering the executive field of railroad operation. Right now there is much dispute as to whether the engineering training fits or unfits a man for executive work. However that may be, we can all agree that the art of getting things done demands the pulling together of men through understanding. This understanding, I take it, can best be acquired by showing interest in the things they are doing and, when the chance offers, by coordinating those things.

It is possible that the tone of these remarks implies an extraordinary burden upon the engineer and intimates that he, of all the great organization with which he is connected, has been the most negligent in recognizing his true place in it and in identifying himself as a part of it. This, I believe, is not so, but I also believe that the engineer's higher education lays upon him a greater obligation proportionately than should be borne by most other classes who make up the railway's personnel. The engineer's high intelligence, together with his mental and physical training by hard work, equip him to bear that responsibility, and he should welcome it and stand ever ready to give in service rather more than he receives. It may seem at the time that his recompense is not very material and that he must do this for the joy simply of giving, but as a matter of fact his service will be of such marked value to his employers and fellow-workers that credit is bound to come sooner or later along with the capacity for handling larger enterprises, so that in the long run will come a substantial return. We are often treated with scant courtesy and less compensation. Our resentment boils up at the lack of appreciation shown by rude and expressive folks who may be shy on grammar, but those folks are making the wheels go around in just about the greatest game there is. Let's line up with them and for them and make the engineer more and more a builder, not only of structures, but of organization.

National Research Council Committee to Study Marine Borers

The National Research Council, with the co-operation of Engineering Foundation, is undertaking an investigation for the purpose of developing protective measures against marine borers. With this end in view the council has appointed a Marine Piling Committee, having the following members:

R. T. Botts, chief engineer, Robbins-Ripley Co., chairman.

George J. Ray, chief engineer, Delaware, Lackawanna & Western Railway, vice-chairman.

A. L. Barrows, assistant secretary, National Research Council, secretary.

George M. Hunt, United States Forest Service.

C. A. Kofoid, University of California.

Hermann von Schrenk, consulting engineer, New York Central Railroad.

This committee has formulated a program for obtaining necessary data immediately so that those interested may be in a position to adopt safeguards at the earliest possible date. It is proposed to appoint such research fellows as may be necessary, to be located at investigative research stations in various parts of the country. The committee proposes to enlist the interest and co-operation of every possible agency in the United States and in Europe. The program includes investigations covering the entire field of marine construction, not only wood construction but cement and metals. In order to carry out the preliminary program the committee proposes to raise a fund of approximately $100,000.

Colonel W. G. Atwood has been chosen director for the investigation and will have his office in Engineering Societies Building, 29 West 39th St., New York.

The committee in preparation for a meeting to be held by the Municipal Engineers of the City of New York on March 22nd, has collected a large number of specimens of marine borers and their work. These specimens represent a number of species of borers and are from various locations on the Atlantic, Gulf and Pacific coasts. These specimens have been placed in the lobby of Engineering Societies Building, 29 West 39th St., New York, for inspection of all who are interested.

Conditions Affecting the Head of a Rail

Destructive Influences Reviewed in Paper Presented Jan. 20, Before the New York Railroad Club

By JAMES E. HOWARD

[illegible]

The rail problem is an open one and will so remain, at least until there is a general understanding of the destructive influences which prevail and the necessary modifications made to ameliorate them. It is not the gross load which, [illegible] as such, which makes the problem a difficult one, but the manner in which the load is applied. The prime and practically the only irremediable cause of rail failures, in the final analysis of the case, is the excessive impinging pressure between the head of the rail and the tread of the wheel.

These remarks refer specifically to the head of the rail. It is an elementary principle in engineering practice to maintain a certain relation between the gross load and the number of square inches of metal provided to sustain it. No application of such a rule is witnessed in respect to the heads of rails. The impinging pressures, in all cases, exceed many times the permissible loads per square inch allowed in other engineering examples. While this disparity goes on increasing, no permanent relief is in sight.

The Choice of Steel for Rails.—In regard to the choice of steel for rails, the opportunity is open to make any desired choice, within limits. Track conditions, however, restrict the choice to hard steel, a steel which in earlier days would have been considered very hard. The softer grades will not sustain present wheel loads without objectionable deformation.

Steel structurally sound, free from interior seams and streaks, is best adapted to meet the general conditions of rail service. It is the task of the steel maker to keep interior seaminess at a minimum, and when this is accomplished the head of the rail will be in a condition to endure wheel pressures as favorable as falls within the ability of the steel maker to control. External seaminess of the rail may be regarded as a negligible factor since failures from such a cause have not been witnessed.

First Straining of Metal at Time of Fabrication. The first straining of the metal of a rail takes place during cooling, at the time of fabrication. Internal strains of compression are acquired by the metal adjacent to the top and sides of the head. In order to balance these compressive strains at the periphery, the metal at the interior of the head is put into a state of tension. The stress equivalent to these strains amount to thousands of pounds per square inch. They have been measured many times in longitudinal direction. There is no reason for supposing that cooling strains of corresponding degree do not exist in lateral direction, thus subjecting the interior of the head to cubic extension.

At times these cooling strains have caused the formation of internal cracks at the center of the head and at the junction of the web and the base. Waring and Hofammann at the Altoona Laboratory of the Pennsylvania R. R. first called attention to a shattered zone which they found along the center of the head in a new rail. Subsequent investigation showed that a similar zone existed at the junction of the web and the base in certain cases. It was further noted that these shattered zones did not extend to the hot sawed ends of the rails. The last circumstance fixed the time of their development at the cooling stage following the last pass of the roll train. A careful search was instituted for shattered metal in rails taken from the track, which resulted in their discovery in quite a number of cases. The rails in which they were found were of high carbon steel. Shattered zones were not found in rails of medium carbon content. The widths of these cracks were infinitesimal, with [illegible] displacement.

Internal cracks have been experimentally formed in rails resembling those in tires more closely than the shattering cracks which have presented themselves in rails. Steel is known to be more sensitive to thermal treatment when first cooled from the ingot than upon subsequent reheating and cooling, a circumstance which may assist in explaining the difficulty in producing at will shattered zones in rails.

After the cooling strains of fabrication are acquired, the next thing that may happen to the head of the rail is straightening at the gagging press. No instance has come to notice in which the fracture of a rail in the track could be attributed to the immediate influence of the gag. Gagging, however, profoundly affects existing cooling strains, causing their rearrangement and even reversing their values. Cooling strains of compression may be changed to strains of tension. Internal strains do not admit of being eliminated by cold bending loads. There will be zones in a neutral state, and those zones may be shifted in position by gagging. The effacement of internal strains, complete or partial, is accomplished only by annealing the steel.

Some Causes of Rail Failures.—Rails may be tested with the head down, and the elongation measured on the running surface. Those of the heavier sections tested in this manner not infrequently rupture without developing their normal extensions. The abrupt change in cross section dimensions at the fillets under the head causes rupture to have its origin at that place, thence extending to the top of the head. In such a fracture the metal does not display normal elongation. It is possible that a heat may be rejected, not through any fault of the steel, but on account of the design of the rail.

Notwithstanding the disparity in size, comparing a rail with the locomotive which it supports, the bending stresses involved, taken by themselves alone, are not disquieting. Track tests made by the speaker in the past and recent tests by others, with different classes of engines, on rails of different weights, and on different kinds of ballast, show a range in fiber stresses which would not be considered sufficient to cause rupture. Under vertical loads rail failures may be traced to definite causes of which bending stresses are components but not the principal ones.

A particular condition which leads to large numbers of rail failures is the cold rolling of the head by the wheels. Rails reach the track in a certain primitive state of internal strain. Additional strains are at once introduced by the impinging pressures of the wheels, which go on increasing until, perchance, rupture ensues. This destructive influence is accountable for many rail failures, for which little consideration has been given.

Exterior strains of compression are necessarily opposed by interior strains of tension. The problem is how to preserve the integrity of the metal in the interior of the head, against strains of tension both lengthwise and crosswise. Failures from longitudinal strains of tension in the interior of the head result in the display of transverse fissures; those from crosswise strains of tension become split heads. No mystery attaches to the formation of either a transverse fissure or a split head; a common cause exists for each. They are the direct consequences of high wheel pressures. Together they constitute practically all the head failures of rails.

Split head fractures occur when lateral flow, penetrating the head sufficiently, encounters an interior seam or streak of structurally weak metal. A minute separation of the metal occurs—the incipient point of a split head fracture. The formation of this incipient crack gives some relief to the internal strains. Wheel pressures restore the state of strain, however, and the incipient crack is increased in size. The process is repeated and a split head fracture is thus progressively formed. Under ordinary track conditions considerable time should elapse before the accumulated internal strains become adequate to start an incipient crack. Once started the rate of development should be an accelerating one. A split head fracture may eventually extend many feet in length, possibly originating at more than one place along the length of the rail.

Lack of Evidence of Presence of Internal Strains. Evidence which would lead to the identification of an internal strain which is on the verge of causing rupture seems lacking. There is a flattening of the grain of the steel adjacent to the running surface. In cross section, a central zone shows flattening without drift. On each side of this central zone flattening of the grain occurs with lateral flow or drift toward the nearest side of the head. The split head fracture does not have its origin in this upper zone of the head, but within its influence and below where it [illegible] microscopically, the grains are distorted in shape. Internal stresses of thousands of pounds per square inch exist without any microscopic evidence of their presence. Divested of the phenomena of permanent set or general elongation the actual separation of adjacent particles when ruptured by shear or by tension does not reach a measurable quantity. These characteristic features which lead to rupture demand consideration. [illegible] of inherent primitive properties occurs as a [illegible] in tests for acceptance of the steel.

A split head fracture is regarded as the [illegible] of structurally unsound steel. It is believed that rails of perfectly sound steel would not display this type of fracture. If the grade of steel was too soft to sustain the wheel loads a mashed head would result, not a split head.

The dimensions of the head, even in the widest rails, admit of lateral distortion, a condition not experienced in the lengthwise direction of the rail. No relief is afforded the lengthwise strains except such lateral increase in width as expressed by Poisson's ratio, that is, the lateral expansion will be from one-quarter to one-third of the direct compression.

Longitudinal strains due to normal cooling at fabrication acquire moderate values in the head; higher in other parts of the cross section. The peripheral metal of the head for the most part is left after cooling in a state of compression, the interior acquiring a state of tension.

Stresses exceeding 20,000 lb. per square inch compression have been found in the upper part of the head, in rails taken from the track. The interior of the head was in a state of tension. Here are the conditions which account for the development of transverse fissures. This explanation of their occurrence was given in the first report of the Interstate Commerce Commission upon this type of fracture, in connection with the Manchester accident of August, 1911.

Following the discovery of a shattered zone in the head of a rail, it was asserted that the proximate cause of transverse fissured rails had been found in this development. Investigation did not confirm this assertion. Transverse fissures were found in rails with shattered zones and in rails without shattered zones, also shattered zones were present in rails without transverse fissures. The results of investigation raised the doubt whether the shattered zone even shortened the life of the rail; whether diffusion of the strains from the wheel loads did not occur and thus an influence was presented which tended to prolong its life.

Railroads Should Acquire More Extended Data.—The railroads are not without opportunity to acquire extended information in respect to the physical condition of the rails since the number of transverse fissures amount to some three thousand reported in one state alone, representing over [illegible] different heats. The practice in vogue of removing from the track all rails of a given heat, when a certain number have displayed transverse fissures does not constitute a corrective measure nor does it increase the common stock of information when no examination is made of the rails removed.

There is a similarity between the development of transverse fissures and split head fractures. Each is progressive in its development, each starts from a definite nucleus, and each usually requires a term of years of service before it makes its appearance as a fractured rail. Transverse fissures usually require for their display a term of four to ten years in the track, but there is no definite period within which they occur. It is a matter of track conditions, not one of time which governs the development of these fractures.

Manganese steel rails display transverse fractures but not of the type called transverse fissures. Transverse fractures in these rails have their origins at the running surface and do not start at the interior of the head; in this respect they are distinguished from transverse fissured rails. The phenomenal toughness of this steel is completely destroyed by the cold rolling action of the wheels. A surface film, a few hundredths of an inch in depth, is affected. Incipient cracks are formed in this shallow film, some of which may extend downward separating the head and possibly a portion of the web, if not earlier removed from the track. A fine hair line marks the presence of such a fracture. Nothing is known concerning internal strains in manganese steel. The difficulty of machining the steel presents an insuperable obstacle.

Notwithstanding the complete loss of toughness at the running surface leading to the fracture of the entire head and half of the web, the rail will still retain toughness in the remaining part of its cross-section. In such a condition the strength of a carbon steel rail [illegible]. Absolute brittleness in the [illegible] would prevail. No lurking danger has been detected in a manganese steel rail, and from this standpoint it is a safe rail. Its ability to retain toughness under such adverse conditions makes it not only a safe rail but the only safe rail under parallel conditions. Its superior [illegible] has long been known.

Wheel Burning Source of Injury to Rails.—A source of injury to the heads of rails, of common occurrence, is wheel burning. They constitute the most numerous group of injuries which are apparent to the eye. Fortunately they are not always as bad as they seem. At times the hardened layers caused by wheel burning flake off. Again cracks in the steel are not arrested at the junction of the hard and soft metal but extend into the normal metal below. This extension of the cracks is a dangerous development. Rails in this condition are among those which are seemingly least affected by wheel burning. Such rails have been found on curves; cracks being formed at close and regular intervals and present on both the high and the low rails.

Wheel burning may occur in which so much heat is generated, heating such a large part of the rail, that hardening by conductivity will not take place. The term "snow burning" is used in some parts of the country having the same meaning as wheel burning, but applying specifically to the stalling of an engine in a snow drift. Under such a condition the head is so generally heated that hardening does not always take place. The severe abrasion and roughening of the surface which results on such occasions weakens the rail and leads to early failure.

It will be realized from this review of the conditions which affect the head of a rail how serious are the influences which are encountered when the rail reaches the track. The destructive tendencies are clearly in evidence from which no rail escapes. Rails are overstrained members. Increase the overstraining forces and rupture will inevitably follow. Decrease the overstraining forces and the lives of rails will be increased.

At best, the problem is how to prolong the lives of rails. They reach the track with a certain margin in strength and therefore of safety. This margin is weakened in all rails and in some destroyed, and all steel is breakable. There are no inexorable exigencies of service, as some would have it believed, that impose excessive demands upon steel, of such a nature that no relief is possible. The oft repeated remark is heard that steel makers know the conditions of service and must make rails to meet them, without considering whether these demands transgress natural laws governing the strength of steel. A corresponding remark might with propriety be addressed the designers of motive power and equipment where wheel loads are established. The exhibit presented in the annual report of rail failures, of which there is no parallel in engineering literature, gives emphasis to the subject.

Furrows Control Soil Blowing in Kansas.—A method of controlling soil blowing in the western part of Kansas has been worked out by county agents, cooperatively employed by the U. S. Department of Agriculture and the Kansas State Agricultural College. The limited rainfall in this area, with alternate freezing and thawing, causes the top soil to become a pulverized mass, which blows readily. During the winter and spring of 1921 the western counties suffered an unusual amount of loss from soil blowing. The most practical method of counteracting the effect of blowing consisted of running lister furrows at intervals of about 20 ft. at right angles to the prevailing wind. The furrows need to be renewed occasionally, and if the weather is unusually dry and windy new lister furrows should be run between the first ones.

Foreign Specifications for Portland Cement.—The U. S. Bureau of Standards, Washington, D. C., has recently completed a summary of the Portland cement specifications of various countries. This included not only the principal requirements but also many of the details of methods of tests, which details are frequently of great importance when considering the specifications of one of the countries. However, for ready reference, the principal physical and chemical requirements have been assembled in a single chart, 16 x 22 in., copies of which may be obtained by addressing the Bureau.

Methods and Cost of Steam Shovel Work at Phelps-Dodge Copper Mines

Interesting information on steam shovel operations at the Bisbee, Ariz., copper properties of the Phelps-Dodge Corporation was given by H. M. [illegible] and George Mieyr in a paper presented at the New York meeting, Feb. 20-23, of the American Institute of Mining and Metallurgical Engineers. The following is an abstract of the paper.

Steam shovel operations may logically be considered under the following major subdivisions: Breaking ground, shoveling, haulage, dump maintenance, and sampling. The discussion of methods and cost in this paper follows this outline, with a brief description of equipment used in the operation.

In breaking the material for rapid handling by the shovels, a combination of bank and toe holes is used to prepare the ground for the powder charge. The bank holes are put down by churn drills. The toe holes are put in with the Burley machines. The average footage per shift for the air drills, in all classes of ground, is 27 ft.

The toe holes are depended on to give the required bench advance at the toe and to maintain a level bench floor. The function of the bank holes is to slope the bank, lessen the burden on the toe holes, and to make the bank safe for the shovel to go under. A slope of 50° is considered desirable and is maintained as nearly as is practicable.

The following table gives the yearly average performance of churn drills, in feet per 2-hour shift, and cost per foot:

Year	Feet per shift	Cost per foot
1918	12.5	$1.74
1919	20.0	1.14
1920	24.2	0.94
1921 [illegible]	31.2	0.55

Bank holes are sprung heavily to take a charge of from 300 to 800 lb. of powder, depending on the nature of the ground. Cordeau Bickford, an exploding fuse, is used as a detonator. The toe holes are sprung to take a charge of from 75 to 150 lb. of explosive and are loaded and fired in strings, the number of holes depending on conditions.

In general blasting operations, it may be said that distributing the powder uniformly through the ground would make finer breaking and would save delays in shoveling. However, the comparitive cost of drilling and loading holes bored by churn drill or air drill must be balanced in deciding on a method of shooting.

The height of bank affects both methods of shooting and shovel results. A gelatine 40 per cent powder, $1\frac{1}{8}$ by 8-in. sticks, was used in springing holes and shooting boulders. Both nitro-starch and ammonium-nitrate powders have been used in bank and toe holes. The following figures give the powder efficiency, in terms of solid yards per pound of powder used, and the cost per yard broken:

Year	Solid yards per pound	Cost per yard
1918	[illegible]	$0.158
1919	1.72	0.115
1920	[illegible]	0.100
1921	[illegible]	0.101

The operating crew consists of nine men: engineer, craneman, fireman and six pitmen. The loading capacity of the shovels in favorable material has never been reached. The record 8-hour shift is 124 cars, or about 2,350 solid cu. yd. The following table gives the average yards per shovel shift, gallons of fuel oil per yard, and the cost per solid yard:

	1918	1919	1920	1921
Solid yards per 8-hour operating shift	[illegible]	828	769	1,038
Gallons fuel oil per solid yard	[illegible]	[illegible]	[illegible]	[illegible]
Cost per solid yard	[illegible]	[illegible]	$0.157	$0.130

The broken material is separated into four products, as follows: direct smelting ore, milling ore, leaching ore, and waste. To date, waste has been the principal material handled although small tonnages of direct smelting ore have been shipped to the smelters at Douglas, about 180,000 tons of milling ore have been placed in stock pending starting of the concentrator, and 375,000 tons of low-grade ore have been placed on the dump for heap leaching. In the earlier stages of the operation, it was necessary to locate waste dumps on adjacent hillsides.

The following table gives the cubic yards hauled per locomotive shift, the gallons of fuel oil used per yard, and the cost, including the maintenance of the dumps.

	1918	1919	1920	1921
Solid yards per 8-hour operating shift	237	338	361	450
Gallons fuel oil per solid yard	1.45	0.95	1.03	0.87
Cost per solid yard	$0.333	$0.239	$0.251	$0.177

Seven shovels are regularly used for loading the broken material. They are all the Bucyrus Co. Model 88 C, which are standard machines designed for such work. They weigh 103 tons, are equipped with 3.5 yd. dippers and locomotive boilers. The maximum lift is about 75,000 lb.

Due to the hard ground and the high banks, considerable damage was done to the main frames, so all had to be reinforced over the front trucks. Also, the size of the A-frame legs was increased from 6 to 7 in. It is proposed in the future to equip all shovels with locomotive-type superheaters.

In starting a large shovel job, heavy costs are to be expected while building up an organization; in this case, the troubles are increased by the shape of the hill and the difficulties of getting the first benches removed. The following table gives the number of solid cubic yards moved per man-shift and the labor costs per yard.

	1918	1919	1920	1921
Solid yards moved per man shift	7.84	11.74	12.02	17.28
Cost per solid yard, labor	$0.500	[illegible]	[illegible]	$0.312

The following table gives the average yearly cost per solid yard:

	1918	1919	1920	1921
Breaking ground	$0.357	$0.239	$0.214	$0.173
Steam shovels	0.236	0.181	0.157	0.130
Haulage expense	0.333	0.239	0.254	0.177
Dump expense	0.040	0.031	0.031	0.023
Miscellaneous expense	0.008	0.008	0.027	0.016
Total	0.974	0.698	0.683	0.519
Monthly labor bonus		0.004	0.022	0.029
Total, direct	0.974	0.702	0.706	0.548

The improvements in costs and increase in efficiency are due both to improvement in the physical condition of the ground handled and the development of a good working organization. The paramount factor in an organization is efficient co-operation. The spirit of co-operation and the incentive to efficiency have been given the foremen, bosses, and men by the posting of graphic charts giving the daily cost and labor efficiencies in all departments. Another factor is the labor bonus based on the yardage per man shift whereby every employe benefits on a percentage basis.

Railroad Betterments in 1922

(Editorial in St. Louis Globe-Democrat, Feb. 18.)

The Frisco Railroad has appropriated $7,766,000 for permanent improvements this year on right-of-way and for motive power and other rolling stock. Such plans have an exaggerated interest just now. They indicate that the railroads are gradually coming back into market both for labor and for materials. A primary influence will be exerted on unemployment conditions because of the increased forces working directly under the railroad managements and a secondary influence will be found in the pay rolls of establishments engaged in the manufacture of railroad supplies of various kinds, whose sales will be stimulated by the improvement programs. The Santa Fe is another railroad which has announced improvement projects of magnitude for the year. The total to be laid out by this great system is $43,150,000, continuing a consistent policy of betterments on which $35,000,000 was expended even during the past rather unsatisfactory year.

Detailed plans show that the Santa Fe will devote $1,400,000 to building a new branch line running west from Santanta in Kansas. It will not be a very long branch line, only 55 miles, but new construction has been attempted so seldom in recent years that the item has signficance. In Arizona, second track will be built for a distance of 75 miles between Yampai and Griffiths, on which the grade will be cut from 95 to 75 ft. per mile. The motive in many costly improvements of similar nature executed by railroads in the past or planned for the future is shown in the statement that a saving of $50,000 a year is expected to result from this grade reduction. For new equipment the road will spend $8,000,000 and $533,633 will go to meet tax assessments for improvements made by public authorities, an item not commonly thought of when railroad outgo is figured.

National Construction Conference.—A national construction conference will be held at the Drake Hotel, Chicago, April 25, under the auspices of the National Federation of Construction Industries.

Should Cost of Tie Treating be Charged to Maintenance?*

By EARL STIMSON,

Chief Engineer Maintenance, Baltimore & Ohio R. R.

The degree of a railway's purchasing power depends on the funds available. These funds could be obtained in two ways: either from moneys earned or from moneys borrowed. Which of these ways is the more desirable from the railroad standpoint depends upon the degree of prosperity of the road or the state of its credit. If the earnings are large it is desirable to put a portion back into the property; and in what better way than to invest in treatment for prolonging the life of ties? If the earnings are low, resort to capitalizing of the excess cost of the ties due to the treatment would be a means of meeting the expense. The road of low earning power would likely have poor credit, and consequently difficulty in securing the necessary funds.

The manner of providing for this expense, however, has beeen prescribed by the Interstate Commerce Commission. Under Account No. 8--Ties, of the Classification of Investment in Road and Equipment, Issue of 1914," we find in this connection, mention made only to include "the excess cost of metal ties used in repairs of track over the cost to replace in kind wooden ties removed "Under Account No. 212, Ties - Classification of Operating Revenue and Operating Expenses of Steam Roads, Issue of 1914, we find: "This account shall include the cost of cross, switch, bridge and other track ties used in the repairs of tracks." Note "B" under this account states that, "The excess cost of metal ties applied in the place of wooden ties over the cost at prices of replacing in kind the wooden ties removed shall be charged to road and equipment account No. 8, Ties."

While no specific mention is made of treated ties, it is plainly evident that the commission does not consider the treatment of ties a "betterment" in the sense in which that word is defined by the commission. Such definition is given as: "Betterments are improvements of existing facilities through the substitution of superior parts for inferior parts retired, such as the substitution of steel-tired wheels for cast wheels under equipment, the application of heavier rail in tracks, and the strengthening of bridges by the substitution of heavier members. The cost chargeable to the accounts of this classification is the excess cost of new parts over the cost at current prices of new parts of the kind retired."

The argument may be put forth that if the substitution of a metal tie for a wooden tie is a betterment, that is the substitution of a superior part for an inferior part, why not the substitution of a wooden tie which has had the length of its serviceability increased by chemical treatment. This may be answered by stating that there is no reason why the treatment should not be classed as a betterment, for the treatment undoubtedly makes the treated tie superior to the untreated tie, as far, at least, as its life, as measured by its resistance to decay, is concerned. On the other hand, it may be answered that there is sufficient reason why the treatment should not be classed as a betterment. In the case of the metal tie substituted for a wooden tie, there is unquestionably a substitution of a superior part for an inferior part, as the tie is made of a radically different and structurally superior material.

The commission evidently considers a wooden tie to be a wooden tie, whether of soft or hard wood, whether untreated or treated. A wooden tie, structurally, is no better after treatment. It will carry no greater load and will not better hold the spikes. Under severe usage it will no better resist rail and spike cutting, and other forms of mechanical wear, unless specially protected with tie plates and screw spikes at considerably additional expense. Under very severe usage the treated tie is destroyed as quickly as the untreated tie. The increase in the length of life of the treated tie is the only point upon which its superiority can be based. The same point can be raised in favor of the white oak or long leaf yellow pine tie, substituted for a red oak or short leaf pine tie.

There are many kinds of treatment, varying widely in cost and effectiveness, the effectiveness not always being in direct ratio to the costs. The effectiveness of treatments varies also with the kind of wood. It is difficult, after a few years, to identify a tie that is being removed from the track, as a treated or untreated tie; and if the former, the process of treatment used, unless a very elaborate record and method of marking for identification be initiated concurrent with the authority to charge the cost of treatment to investment in road; that is, to capital account Otherwise it would be impossible to accurately separate the charges.

The rapid rise in the price of timber has increased the price of the tie in much greater proportion than the cost of treatment has increased. Less expensive treatments, that have been found adequate, are being used more and more in place of the more expensive treatments formerly considered necessary. The result has been that the ratio of the cost of treatment to the price of the tie has greatly decreased, making the use of treatment not only show greater economies, but also reducing the proportion the excess cost of treatment bears to the total cost of the treated tie. This should in itself stimulate the use of treated ties and not make necessary resorting to the doubtful expedient of capitalizing.

The steady increase in the use of treated ties, until now a large percentage of ties used are treated, rather nullifies the idea that the present method of charging out the cost of treatment to maintenance is preventing a more liberal use of treated ties. Nor does it appear that the charging to investment in road, that is capitalizing, the excess of the metal tie has brought about the extensive use of that tie, or made it even a competitor of the treated tie. Millions of treated ties are used to thousands of metal ties.

The writer has treated this subject, not from the standpoint of the accountant or the financier, but rather from the more lowly standpoint, i. e., nearer the ground, of the maintenance engineer. He has cheerfully taken into his maintenance costs the expense of treating to date some 12,000,000 ties. He is even now reaping to no inconsiderable extent the full benefits of the price paid. He is not and will not be compelled throughout all time to give up some portion of those benefits in payment of interest charges, or in other words, to pay tribute to capitalizing. The writer favors the present practice of charging the cost of treating ties to maintenance.

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*From a paper presented at the annual convention of the American Wood Preservers Association, Chicago, Jan. 24-26.

New York's Terminal Projects

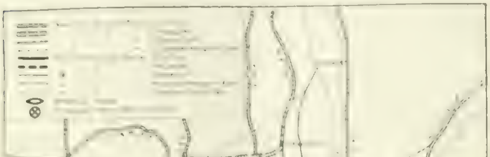
By a final approval late in February of the Port of New York project, the states of New York and New Jersey have given the last necessary authority for the development of the port, freed from the hampering restriction of state boundary lines. The city of New York has also been ordered by the legislature to construct a tunnel under The Narrows, thus connecting the boroughs of Brooklyn and Richmond, and providing certain improved railway terminal facilities.

The Port of New York authority is pushing the bi-state project, and the Board of Estimate and Apportionment of New York City is urging the carrying out of The Narrows tunnel scheme, with its associated developments. The costliness of either project makes it improbable that more than one of them will be undertaken and the controversies over their respective merits have developed some acrimony.

We print herewith a map taken from a progress report published Jan. 23, 1922, by the Board of Estimate and Apportionment, and showing roughly the location and some features of each route. Perhaps the most striking feature of the map is the large portion of the outer belt line which is common to both projects. The port project, however, does not call for the immediate completion of this belt, but leaves it largely for future development as needed. For the immediate future the Port Authority would use what it terms "the middle belt line," of which 17.1 miles, including a tunnel under Upper Bay, is on its initial construction program.

The length of the Port Authority tunnel would be 24,290 ft., and the length of the city's tunnel 22,750 ft. The maximum grades would be 1.6 per cent for the Port tunnel and 2.0 per cent for the City tunnel. The Port Authority's estimate of the cost of its 17.1 miles of belt line, including the tunnel, is $65,000,000. The City's engineer's estimate of the 67.5 miles of belt line and tunnel called for by the City's plan is $93,000,000.

The New York City plan requires that a large part of the development be undertaken and financed by the railroads, and this a majority of the roads have refused to do on the ground that the project is less economic than the further development of present facilities. The tunnel and certain other features would be financed by the city presumably to considerable advantage because of the city's favored position as a borrower. The Port project would have to be financed independently and the cost of the funds might be greater than to the city. The City's project provides for a large clearing yard on Staten Island (Borough of Richmond) in which freight arriving over the various trunk lines would be made up in trains for final destinations about the port. Proponents of this plan claim that special break-up yards for each trunk line are unnecessary. The Port Authority's contention is that break-up yards are necessary, and that such yards sufficient for present purposes already exist outside the congested area in New Jersey. The location of these yards appears on the map.



Map Showing Narrows Tunnel and Port Authority Routes of New York Terminal Railways.

The chief function of the outer belt line is to by-pass freight around the congested industrial districts in New Jersey. Critics of the city's plan say that while it provides an admirable by-pass, it fails to provide the greatly needed improvements in terminal facilities, particularly for Manhattan Island. Critics of the Port project say that the postponement of development of the outer belt line is a serious mistake; that the long tunnel under the bay involves an unnecessary excess of expense over The Narrows tunnel; that the project will add to, rather than reduce, the congestion in New Jersey; that the crossing of waterways by draw bridges will present constant delays and other difficulties, and that Staten Island with all its natural possibilities, will be left on a stub end with entirely inadequate connections with the rest of the terminal. The City's project, it should be noted, provides for the crossing of all waterways by tunnels or by high bridges. The importance of developing Staten Island is continually emphasized by the engineers for the city. Radical differences in the two projects render it impossible to make really significant economic comparisons without devoting very many pages to that purpose.

Portland Cement Output in January.—The production of Portland cement in January, according to the U. S. Geological Survey, amounted to [illegible] bbl. The shipments totaled [illegible] bbl., and the amount in stock at the last of the month was [illegible] bbl.

Selling Engineering Service

A Discussion of a Paper on the Above Subject by Paul E. Green, Published in Engineering-Contracting Feb. 22, 1922

By ARTHUR M. SHAW,

Consulting Engineer, New Orleans, La.

This should be a live subject with all engineers, whether they be salaried employes or in business for themselves, but it has not received the attention or at least, the interchange of ideas which its importance justifies.

Every day we are becoming more hemmed in (and properly so) by various codes of ethics and there is no lack of discussions as to what steps an engineer may not take in his efforts to bring in new business. Many individuals and firms of extended experience have developed efficient methods for handling the various details of their business but they have not usually been ready to make available for others the intimate details of their methods as has been done so generously by the author of the paper under discussion. The ideas presented by him are of special value as they obviously have been drawn from a personal experience which may be considered as representative of a large number of engineers who left salaried positions to open businesses of their own.

While the experience of the author tallies very closely with my own so far as it relates to efforts of the going concern to secure new business, a suitable combination of circumstances may make the change to an independent business possible without the comparatively large margin of capital mentioned. To draw from my own experience, the transition was made quite painlessly, owing to the fact that I was able to "taper off" gradually from a rather important position. As the work drew to a close, the salary was reduced but I was given a considerable amount of free time to work up new business. This arrangement continued for a year, followed by another year of still further reduction of salary with a corresponding increase in amount of free time. This gave me an opportunity to go after other work, at the same time leaving me practically enough for necessary expenses. The change was not made without some periods of anxiety as to the final outcome but the method proved so satisfactory that it is recommended to others who may have an opportunity to give it a trial.

There is one class of work which is especially suited to men who have the proper experience and training and who are just starting in business for themselves. This is the furnishing of advice and engineering service to small railway companies, public service corporations and other concerns which encounter engineering problems but the size of which does not warrant the employment of a first class engineering staff on full time. A connection can be made with such interests which will make it possible to give to them a higher grade of technical service than they could afford to employ as a full time part of their regular organization. The writer finds that a most satisfactory plan includes the payment of a moderately small monthly retainer fee to cover ordinary consultation, periodical inspections and routine service, an extra charge being made for special services, field surveys, etc. Though such clients are given special consideration in the scale of prices charged as they are the "bread and butter" line and frequently may be depended on to carry the office through a dull period.

The paper under discussion and the foregoing comments apply particularly to the business of the practicing engineer but the writer feels that a few words should be added for the benefit of those men of the profession who have occasion to make application for salaried positions. The following are the result of an experience of over 30 years. During the first half of this period reams of paper were used, much postage wasted and many trips taken to secure either a position or a job. Following the law of compensation, the later years have brought in almost an equal amount of paper in the form of applications from others.

For the sake of brevity much of the following will be stated in the arbitrary form of rules though they should be followed only until some better method is discovered for transmitting to a prospective employer the idea that the applicant is the "one and only" candidate to be considered

In forming your application, put yourself in the other fellow's place. This will give you something of his point of view and thus give you a clue as to the class of data which you should present and the form in which it should be presented. You will realize that he will be particularly interested in your fitness for the position as evidenced principally by your technical training, experience in similar lines, capacity for work, age, physical fitness and ability to "get along" with employers and fellow employes. Assuming that your own time and also the patience of the official to whom you are writing are both unlimited, you may feel that you can convey all this in a letter of not more than 10 or 12 pages, but this assumption as to the latter is not safe. The problem then becomes: "How shall I convey the essential details in the shortest form?"

Having "put yourself in the other fellow's place," you will get the idea that he is a busy man, therefore be brief; that as he has a position to fill, he will be interested in what you have to offer, therefore be clear; that he is an engineer, or at least is familiar with engineering methods, and therefore will appreciate the fact that tabulation is the most convenient form for the presentation of data which will lend itself to that form of composition.

With the foregoing in view, make your application in the form of a short, personal letter. If you know the name of the official charged with the duty of selection of new men, address him by name, but using his title also. This does not apply to Government officials, particularly army officers. Such applications should be made to the office and not to the individual.

Confine your letter to one page, preferably to half a page.

Accompany the letter with a tabulated statement of your technical training and experience and other data which would ordinarily be required in filling out application blanks. When blanks are furnished, fill them out as directed. If spaces furnished are inadequate for putting down data considered essential, use an extra sheet, making cross reference in the space designed for the special information.

The letter should be an "original," written for the specific purpose, but clear carbon copies of the tabulated matter are suitable.

Ordinarily letters of recommendations should not be sent with an initial application for employment, though copies may be sent with subsequent correspondence if negotiations are opened. Never send originals unless specifically requested and then only with definite assurance of their safe return. (This last point has been brought out so many times by other writers that it would not have been included had I not received an application only a few months ago from a young engineer who not only mailed me six service and other original letters but his original army discharge papers. These were all returned under registered mail with some good advice which it is hoped was received in the spirit in which it was offered.)

Use standard letter size for all papers (8½ by 11 or 8 by 10½). Most business houses use the larger size while the Government offices use the smaller.

The following is submitted as being in good form as a letter of application but not to be used as a "Form Letter":

216 Coombs Ave., Columbus, Ohio, March 1, 1922.

Mr. John Smith, Chief Engineer,
X., Y. & Z. R. R.
711 Michigan Ave., Chicago, Ill.

Dear Sir. Noting in the current number of "Engineering and Contracting" that your company is contemplating the construction of a two hundred mile extension in Oklahoma, I wish to take this opportunity to make application for a position as Chief of Party or as Transitman on either location or construction. I desire particularly to secure a position which may lead to permanent employment if I can prove myself to be the right man for the place.

Am now employed in a temporary position from which I can be released on giving three days' notice. Can be reached at the above address at any time within the next two months though my permanent address is: Care James Jones Hardware Co., 17 Main St., Xenia, Ohio.

Attached is a brief statement of my technical training, experience, etc.

Yours very truly,

JAMES JONES, JR.

Technical Training and Experience.

James Jones, Jr., care James Jones Hdw. Co., 17 Main St., Xenia, Ohio. Temporary address (until May 1, 1922) 216 Coombs Ave., Columbus, Ohio.

Age, 29 years. Nationality, American. Unmarried.

Schools.

1908—Graduated from High School, Xenia, Ohio.

1908-1912—C. E. course at X University—Degree B. S. in Engineering.

Experience.

1910—Summer vacation (10 weeks), chainman and rodman on preliminary surveys for the A——, B—— & C—— Ry. Mr. ———, Resident Engineer.

6-1912 to 10-1914—Rodman and leveler, E——, F—— & G—— R. R., Memphis Division. Track maintenance, location of short branch lines, construction of industry tracks, etc. Mr. J—— H———, Division Engineer. Resigned to accept better position.

11-1914 to 10-1916—Transitman for three months and later Resident Engineer for the A. B. Chemical Works at ———. In full charge of all building construction, track location, etc.

11-1916 to 5-1917. Resident Manager of above Chemical Works. Complete job cost $2,520,000.00. Amount expended under my responsible supervision, $780,000.00. Resigned in good standing to enlist in the Army.

6-1917 to 10-1918—Private, Corporal, Sergeant and 1st Sgt. X U. S. Engineers. Sent overseas in February, 1918. Principally engaged in road construction immediately in rear of French line.

10-1918 to 2-1919—1st Lt. X U. S. Engineers. Honorable Discharge Feb. 18, 1919.

4-1919 to 6-1921. Engineer in charge of location of line and construction of track, bridges, etc., P. & Q. Interurban Electric Ry. running from ——— to ———, total length 14 miles. Cost of work done under my responsible direction $280,000.00. Line purchased by a larger system in June, 1921, and my position abolished.

11-1921 to date—Asst. Sales Manager of Engineer Supplies Dept., The A. & R. Sales Company.

References.

Employers.

Mr. ———, Asst. Engineer, A. B. & C. Ry., Troy, N. Y.
Mr. ———, Div. Engr., E. F. & G. R. R., Memphis, Tenn.
Mr. ———, Vice Pres., A. B. & C. Chemical Works, —— Wall St., N. Y.
Col. ———, Ft. Sam Houston, San Antonio, Texas.
Mr. ———, Former Pres. P. & Q. Elec. Ry., ———, Ind.
Mr. ———, Gen'l Sales Mgr., The A. & R. Sales Co., Columbus, O.

General.

Pres. Union Trust & Savings Bank, Xenia, Ohio.
Prof. ———, Dean of College of Technology, X University, ———, Ohio.
Mr. ———, Attorney, Xenia, Ohio.
Mr. ———, —— Front St., Memphis, Tenn.

(Signed)

If you are so fortunate as to receive an encouraging reply to an inquiry for a position, do not be so hasty with your reply that it will cause you to overlook any questions which may have been asked. A good plan is to write down a first draft in pencil, then study it over, comparing with the letter which you have received to make sure that each point has been covered fully and clearly. After making any necessary corrections or additions, re-write in ink (or with typewriter).

A Philosophy for Contractors

Address at Annual Dinner Associated General Contractors

By ARTHUR S. BENT.

As I have sat here looking out over this remarkable gathering a very vivid contrast has arisen in my mind. I have been picturing to myself contractors' meetings of earlier days which were not at all like this one. They were usually secretly held. Their spirit was selfish, if not worse. The meeting place was usually a box car or the back room of a saloon. (Possibly the picture brightens a bit for you there.) The decorations were not like these; they were large square boxes of sawdust on the floor, and after the meeting was over you wondered why they were put there.

The interests of the public, however, were not forgotten; they were given the most solicitous consideration—of the same sort that a cannibal gives a toothsome missionary.

There was no spirit of brotherhood and co-operation and sympathy such as we have here tonight. They came together because the strength of the wolf lies in the pack. There was always fear and cunning and distrust in their hearts and they parted to plot ways for double-crossing each other.

Those of us who attended those early day meetings never took our wives; I doubt if we ever spoke of them; and I have been wondering as I sat here if this new day in our industry isn't fittingly typified and in large part explained by their gracious presence here tonight. When a man takes a good woman into his business counsels, he has right then set his feet in the pathway to success, and when a great industry like ours invites its women to be present at its conventions, it has certainly stepped out of the shadows and into the light.

I wouldn't be understood for a moment as raising any question as to whose hand it is that has always rocked our boat—I mean ruled our world. The only difference is that now we are proud to acknowledge it.

Practically all of us contractors have struggled up from small beginnings and you will bear me out when I say that in the faith and sympathy and patience of our wives, our own courage and hope have always found their surest anchorage. We welcome the presence of the ladies at our convention; we really do believe that this new era in our in-system is best exemplified by our armed partners. And I think you too may be proud of the partnership. There is no longer any occasion for you to ever wonder why your husband couldn't just as well have been in some respectable business.

The industry that we represent is not alone very great. It was the one hope of a shattered world lying almost in ruins until yesterday. Men may fight and destroy for a time, they can build forever and the very continuity of life itself depends upon construction.

There is a very beautiful legend, an impressive one, I think, so old that its origin is lost—I have never been able to discover it. It goes like this: Four men stood up with God when He made the world and watched with wonder as the glimmering sphere flung from the fingers of Omnipotence found its place in the shining galaxy of stars.

And one of the men said, "How was it done?" And God said to him, "Go find out for yourself." And that man went and became the Scientist.

And the second man said, "What is it for?" And to him God said, "Go, find for yourself." And he went and became the Philosopher.

"Give it to me," the third begged. And to him God said, "Go possess it for yourself." And he went and became the Business Man.

The fourth said nothing but fell down and worshipped, and God said to him, "You, too, shall go and because your soul sings within you, you shall create beauty," and that man went and became the Artist.

Now may we not reverently and not unfittingly, add to this noble group of God's journeymen the Constructor? We who serve, and always have, the others? We who have straightened the path for their feet? We without whom their high destinies could not be wrought out and by whom all their visions are crystallized? We work and delve for Science in its onward march, and harness its magic to ways of usefulness. The bewildering and marvelous structure through which Business functions is the work of our hands. Philosophy leans upon us heavily to demonstrate its theories of life and even to Art we give its tools and makes its dreams of beauty imperishable.

We are the hands through which nearly all of human thought and all of material progress are expressed. Through our highways and railways and lighting and heating and temples and schools and homes we touch all life intimately and come very close indeed to the heart of humanity, and with that vital and varied contact comes to us an impressive but inspiring responsibility. It is given to us, if we see it rightly, to raise the standard of every man's service by the fidelity of our own.

Of course ethical achievement is not statistical. We can't tabulate our progress along those lines. Nevertheless, I firmly believe, and you do too, that it will be our real, our most profitable progress. The span of our activities is not limited, however, to our own present interests. We are trying to make contracting a finer thing for those who will come after us. We are consciously sowing seeds which will be harvested by those whom we can never know. Is there any finer thing in life than that? I will just leave with you that thought, expressed again in a homely little poem called The Bridge Builder.

An old man, traveling a lone highway,
Came at the evening cold and gray,
To a chasm vast and deep and wide.
The old man crossed in the twilight dim,
For the sullen stream held no fears for him,
But he turned when he reached the other side
And builded a bridge to span the tide.

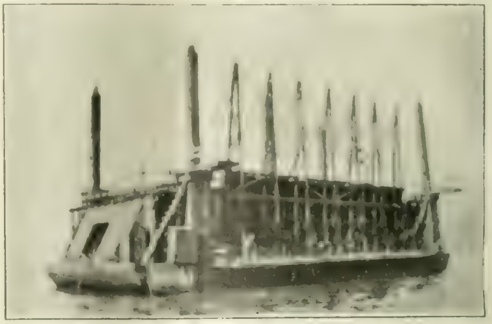
"Old man," cried a fellow pilgrim near,
"You are wasting your strength with building here.
Your journey will end with the ending day,
And you never again will pass this way.
You have crossed the chasm deep and wide,
Why build you this bridge at eventide?"

And the builder raised his old grey head.
"Good friend, on the path I have come," he said,
"There followeth after me today
A youth whose feet will pass this way.
This stream, which has been as naught to me,
To that fair-haired youth may a pitfall be.
He, too, must cross in the twilight dim.
Good friend, I am building this bridge for him."

Method of Measuring Drill Holes in Submarine Blasting

By WALDEMAR POLACK.

In drilling on Diamond Reef, East River, New York, a time-saving method for measuring the depth of the holes has been found. The usual method has been to tie a tape to the drill rope at the top of the casing, then lift the steel out of the hole until the top of the stem has been reached. The length then indicated on the tape, plus the stem, plus the bit (which last two items are constant or readily measured when the stem or bit have been changed) would be the distance from the top of the casing to the rock. The required depth is from rock to mean low water. To obtain this, the distance from top of casing to deck is measured as also the distance from deck to water, and then the tide added to these two items and the sum of the three subtracted from the first total. This gives the depth of the hole below mean low water.



Drill Boat on Diamond Reef, New York.

Every hour it was customary to send a motor boat to the tide gauge on shore to read the tide. At times the tide was estimated, but, due to unusual conditions, especially of wind, this was often found to be inaccurate. To overcome the necessity of sending for the tide hourly, it was sent for once and a gauge put on the spud, but it was found that when the spud engine was applied to it, as it is with the rise and fall of the tide, the spud sank in the soft rock enough to make an appreciable difference.

The method employed by the writer is this: After a casing has been driven and the hole has been going for a few hours so that I am sure it is in solid rock, I use the top of that casing as a bench mark. As the casing is independent of the scow, movement of it does not affect the elevation of the casing. I send for the tide reading, say it is plus 1.2; measure casing to deck, it is 4.5; deck to water, 3.7. Total subtractive element to mean low water is now 9.4. I know now that hour to hour variations of the tide will not effect 9.4. To find subtractive element for the other casings I take only the distance of the top of the bench mark casing to the deck, which in this case is 4.5. So, the subtractive element for other casings is 9.4 minus 4.5 or 4.9 plus their casings to deck. Thus I avoid measuring from deck to water. Next hour the 9.4 still holds good, but now the distance from casing to deck may be 3.8. In this case subtractive element for all the casings is 9.4 minus 3.8 or 5.6 plus individual casing to deck measurements.

As a check it is usual at the end of about six hours, to send over for another tide gauge reading. The writer measures casing to deck, and deck to water. In this case it may be 1.4 for casing and 3.0 for the water, or a total of 4.4. This would require a tide of plus 5 ft. to make 9.4 the constant. If the tide is 4.9 or 5.1 (as is usually the case), I am positive of every intermediate reading.

The saving of time consists in eliminating the necessity of sending for the tide reading and measuring distance from deck to water.

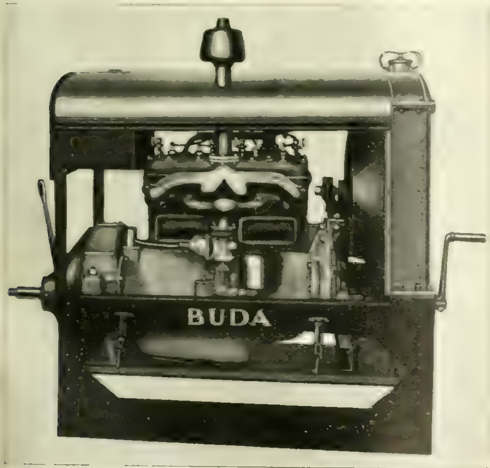
Municipal Street Railway Operation at Calgary.—Calgary's (Canada) municipal street railway carried 18,771,271 passengers in 1921, an average of 65.2 per car hour. The estimated revene of the system for 1922 is $935,000 and expenditure $993,430.

A New 4-Cylinder Unit Power Plant for Construction Operations

A 4-cylinder unit power plant, applicable for light and power purposes for construction camps, and for railroad and bridge construction, and for other purposes where an independent power plant is required, has been placed on the market by The Buda Co., Chicago, Ill. These engines are of the heavy duty type. The cylinder heads are securely fastened by alloy steel studs, easily removable for purposes of inspection or cleaning carbon and regrinding valves. Pistons are of the four ring type, having three rings above the wrist pin and a wiper ring below. Connecting rod forgings are chrome vanadium steel carefully heat treated. All crank shaft bearings and lower connecting rod bearings are heavy bronze back, babbitt lined, securely held in place by retaining screws. The valves are made of alloy steel in one piece accurately finished. Valve springs are of the barrel type, self-centering, which eliminates thrust on the valve stems. Push rod assemblies are easily removable without the necessity of removing valves from the engine. The crank shaft is of heavy design, made from special forging quality open hearth steel. The power plant is furnished in five sizes, ranging from 20 to 51 B. H. P. as follows:

Unit No.	R. P. M.	[illegible]
20	1,000 to 1,450	20 [illegible]
25	900 to 1,400	21 [illegible]
30	800 to 1,250	24 [illegible]
40	800 to 1,000	31 [illegible]
50	700 to 1,000	38 [illegible]

The power plant will be furnished for direct connection to an electric generator, or with friction clutch or driving pulley. Direct connected to electric generator the sizes and outputs are:

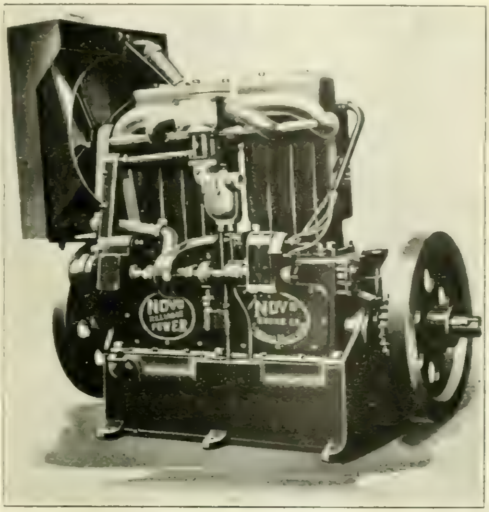


Buda Unit Power Plant.

Unit No.	Direct current R. P. M.	Direct current K. W.	Alternating current R. P. M.	Alternating current K. W.
20	1,450	16.5	[illegible]	14
30	1,200	20	[illegible]	[illegible]
40	1,000	25	[illegible]	[illegible]
50	925	30	[illegible]	[illegible]

A New Engine for Operating Construction Equipment

A new gasoline engine of the 4-cylinder, 4-cycle vertical type designed particularly for the construction field, has been brought out by the Novo Engine Co., Lansing, Mich. These engines are from 10 H. P. to 40 H. P. They are designed to set on a flat foundation like other industrial engines. They are provided with a substantial base, which forms the fuel tank and lower part of the crank-case, containing the oil pan. The bottom of the base is planed parallel to the center of the crank-shaft. This new series of engines will be known as the Novo Type F and consists of Model AF with 3¼-in. bore and 5-in. stroke; Model CF with 4-in. bore and 5½-in. stroke, and Model EF with 4¾-in. bore and 6-in. stroke. The Novo Type F engines are somewhat heavier than the tractor or truck type of four-cylinder engine. They are slower in speed and have heavier crank-shafts and larger bearings. In short, they are in every respect made exclusively for use with industrial equipment. In Model AF the cylinders are cast en bloc with the upper half of the crank-case; in Model CF the cylinders are en bloc and bolted to the crank-case, and the cylinders of Model EF are cast in pairs and bolted to the crank-case. The speeds, weights, etc., of the three models, are as follows:



Model E.F. Gasoline Engine.

Model.	Bore and stroke.	Speed.	Weight.	Height including radiator In.	Length. In.	Fly wheel diameter. In.
AF...	3¼x5	850-1,000	800	34	36	17
CF....	4 x5½	750- 900	1,300	44	48	20
EF....	4¾x6	650- 800	1,500	56	57	22

News Letter

ST. LOUIS ITEMS.

By A. B. Koenig.

St. Louis had the best old time contractors' convention on Feb. 27 and 28 that was ever known. In reality it wasn't a convention, but a congregation of all the prominent railroad contractors in this part of the country to submit bids on five good-sized steam shovel jobs to be let by the Frisco R. R. in the states of Missouri and Kansas. Grant Smith & Co. of St. Paul came under the wire first on four of them in Missouri. The Walsh Construction Co. of Davenport, Ia., landed the job between Spring Hill and Paola, Kans. The J. W. McMurray Contracting Co. will do the masonry and concreting on this job. James Hedges will do the masonry and concreting on the Smith jobs in Missouri. Among the firms and representatives that submitted bids and attended the letting we noticed Grant Smith & Co., Swan [illegible], H. H. [illegible], Geo. R. Putnam, St. Paul; The Walsh Const. Co., Tom Walsh, Hummer Kahl, Dan S. Terry, J. F. [illegible], Davenport, Ia.; L. J. Smith Const. Co., Z. C. Mitchell, Kansas City; J. W. McMurray Contracting Co., Roger Faulkon, Kansas City; Jim Hedges, Springfield; Dunn & McCarthy, Jim Dunn, Ed McCarthy, P. [illegible]; Frazier Bros., Chicago; Winston Bros. Co., W. J. Rohan, Minneapolis; Foley Bros., Inc., Minneapolis; John Marsch, Nick Marsch, Chicago; Roach & Stansell, Memphis; H. F. [illegible]; Clapp, Norstrom & Riley, Chicago; Russell [illegible], Omaha; Morris & Dougherty, Minneapolis; Last, Gifford & [illegible], Kansas City; Reed & Lowe, Charlotte, N. C.; Ed White, Kansas City; Chas. Marshall and L. I. Wall, Kansas City, and all the St. Louis contractors. Everybody enjoyed themselves and there were more railroads built here in two days than all the government treasuries of the world will be able to finance.

Jones & Jordan landed four miles of state road work near California, Mo.

Scott & White are going to sublet the grading on their Santa Fe work west of Santanta, Kans. Will do the balance of the work themselves. Up to the present time they have not let any of the grading, but we look for Al Gilliard, W. A. Cole & S[illegible] and [illegible] Collins to be on the line.

Contractors intending to bid on any of the Missouri state road work coming up will find a complete list of work to be let on file at the Koenig Labor Agency, 61[illegible] Walnut St., St. Louis, Mo.

J. L. Simmons dropped in on his way back from Florida. Simmons has a 15-team outfit idle at La Plata, Mo.

The General Contracting Co., 357 W. [illegible] St., Chicago, Ill., has a good rock outfit idle that they can place on work immediately.

G. V. Cooper, 711 Grant Court, Davenport, Ia., wants a slip, fresno or wheeler job suitable for a [illegible] outfit.

J. L. Kelley got in on six miles of road work in Kiowa County, Kansas. Moving his headquarters to [illegible], Kans.

[illegible]

[illegible] Kansas City, Mo.

[illegible]

[illegible] in their new branch [illegible]

[illegible] outing around trying to locate a job suitable for his [illegible]

[illegible] team [illegible]

[illegible] F. W. K[illegible] & Co., board- [illegible]

[illegible]

Personals

[illegible] Health [illegible]

[illegible]

William D. Pence [illegible] South Dearborn St., Chicago. He will specialize in railroad and public utility matters, valuation [illegible] reports and [illegible]

Obituaries

John Fogelberg, a pioneer railroad contractor of the north- [illegible]

Charles R. Rockwood, [illegible] Imperial Valley [illegible] Northern Pacific, Yakima & Kittitas Irrigation Co., [illegible]

Carl H. Niemeyer, [illegible] Philadelphia [illegible] Pennsylvania [illegible]

Capt. Horace G. H. Tarr, [illegible] March 2 [illegible] Philadelphia. [illegible] in the Civil War [illegible] Brooklyn, N. Y. [illegible] Pump Works [illegible] Chicago [illegible] Philadelphia.

Industrial Notes

The U. S. Cast Iron Pipe & Foundry Co. has opened a new office [illegible] Mo., which will be in charge [illegible]

E. A. Cahill, [illegible] manager for the Concrete Steel Products Co. [illegible] Steel Co., at Oklahoma City, Okla., is now with the [illegible] & Foundry Co. [illegible] concrete.

The Ball Engine Co., [illegible] Pa., has changed its corporate [illegible] Erie Steam [illegible] The change was made in order [illegible] Ball steam engines for power plant use [illegible] shovels and locomotive cranes. There has been no change in the assets, policies, management or [illegible] Ball [illegible]

Mr. and Mrs. Henry Harnischfeger left on Jan. 28 on a combined business and [illegible] around the world. Mr. Harnischfeger is [illegible] president of Pawling & Harnischfeger Co., Milwaukee, [illegible] Japan, the Philippines, China [illegible] India [illegible] Suez [illegible] New York [illegible] Mr. Harnischfeger is also [illegible]

Hundreds of tons of Austin machinery will [illegible] pal improvements [illegible] several more [illegible]

The Westinghouse Electric & Manufacturing Co. has announced [illegible] Pittsburgh [illegible] San Francisco [illegible]

Arthur Whitecraft, M. E. [illegible] Steel Co. [illegible] New York Central Railroad [illegible]

Building and Structural Monthly Issue

ENGINEERING AND CONTRACTING

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation (c) Quarries and Pits
(b) Management and Office System (d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings (d) Miscellaneous Structures
(b) Bridges (e) Properties of Materials
(c) Harbor Structures (f) Managament and Office System

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The Deficiency in Construction During the Past Eight Years

By H. P. GILLETTE AND J. C. BLACK, Editors

Although much has been written about the deficiency in construction during recent years, we have not seen any quantitative analysis showing the total deficiency in any class of construction other than buildings. Table 1 herewith shows a total of $9,107,000,000 estimated deficiency in the three fields of railways, public works and buildings. Other deficiencies some of them very large, as in the case of the street railways with an apparent shortage of nearly $2,000,000,000 are omitted from the estimate because of a lack of adequate data upon which to base calculations. Following our Civil War there was an abnormally great construction era for about seven years, attributable in part to the remarkable extension of our railway systems, but largely to the subnormal construction during the four years of war. May we not now look forward to a similar supernormal volume of construction, and, if so, what is the aggregate deficiency that must be made up?

Before answering the latter part of this question in detail, it may be well to call attention to the fact that annual construction for a considerable period prior to the World War was about $3,100,000,000 distributed as follows:

Buildings	$1,600,000,000
Railways and public utility companies	1,000,000,000
Public works (other than buildings)	500,000,000
Total annual construction	$3,100,000,00

About 40 per cent of the building cost was for residences. Of these three classes of construction, public works is the only class that did not suffer an enormous curtailment during the past seven years. Public works were greatly reduced in all lines except roads, until the last two years; but with roads included, as in the tables here presented, the net total deficiency is not conspicuous. The fact that even the last two years' construction, when reduced to prewar price levels, shows deficiencies below the prewar average explodes the theory that the tax exempt bonds of states and cities have caused national extravagance in public works construction. On the contrary, when allowance is made for an increase of 10 per cent in population during the past seven years, there has not been a single year since 1915 that shows a per capita volume of public works construction equal to the prewar average.

It is true that the closing months of 1921 and the first two months of 1922 show a volume of state and city bond sales that forecast an abnormally large construction of public works in 1922; but the wisdom of such supernormal construction should be apparent. Herbert Hoover expressed, we believe, the opinion of all economic students when he advocated an extensive program of public works construction. Long prior to his public utterances on this subject we had published many editorials advocating this policy, for it was clear to us that the public should lead the revival of business, and that this could best be accomplished by greatly increased expenditures for public works. The lower part of Table V shows the effect of propaganda along these lines, for there we see that the total of state and municipal long-term bonds sold during the last half of 1921 totaled more than $900,000,000, or 15 per cent more than were sold during the entire year of 1920, or 125 per cent more than were sold during the corresponding six months of 1920.

This achievement augurs well for public works construction in 1922, and an almost equally satisfactory outlook as to residence construction is now assured. But quite another

TABLE I.—SUMMARY OF EXPENDITURES NECESSARY TO MAKE UP EXISTING DEFICIENCIES IN CONSTRUCTION OF BUILDINGS, STEAM RAILWAYS AND PUBLIC WORKS

	At prewar price levels.	At present price levels.
Buildings	$2,176,000,000	$4,026,000,000
Railways	3,092,000,000	4,947,000,000
Public works	84,000,000	134,000,000
Total	$5,352,000,000	$9,107,000,000

[illegible] is to be read in the steam and electric railway field. While these fields will show some construction improvement in 1922 over 1921, such improvements will remain woefully inadequate.

As will be shown in detail, there is a 7 year accumulated deficiency in construction of the steam railways that totals $3,092,000,000 at prewar prices, or $4,947,000,000 at present prices. To make up this deficiency would require a supernormal annual construction of 41 per cent for 10 years. But where is the money coming from? Rate regulating commissions have, in so many instances, held down railway rates to such a low level that capitalists have long refused to invest adequate amounts in new railway construction and equipment, and there is no immediate prospect of the exercise of better judgment by the chief railway rate fixing body, the Interstate Commerce Commission. The steam railways have been financially starved for 15 years, and it will require a very marked change in the attitude of rate regulating commissions toward them before much new capital will enter this enormous field.

What is true of steam railways is true in slightly lesser degree only of electric railways. The outlook is still dismal for that big field, but it is slowly improving, because state public utility commissions are gradually coming to realize that most cities can not continue to grow much in area unless transportation facilities are improved very greatly, and that adequate facilities will not be provided until an adequate return is granted not only to new capital that enters the field but to the old capital already invested there.

Shortage in Railway Construction.—Table II shows that total railway construction in the United States from June 30, 1913 to Dec. 31, 1920 was about 3 billion dollars less than would have been the total of a 7½-year period at the average annual rate of construction which obtained from 1903 to 1913, when equated to the index or price level of 1913.

The table was prepared as follows: Investments shown in Column B for the years 1908 to 1920, inclusive, represent actual property investments as reported to the Interstate Commerce Commission and published in the 34th annual report of that body. They do not include investments of switching and terminal companies, amounting in 1920 to about $500,000,000. Investments for the years 1903 to 1907, inclusive, are based upon increase in total capitalization, as shown by preceding commission reports.

The construction cost index is that of The Associated General Contractors of America, printed elsewhere in this issue of Engineering and Contracting. While this is intended primarily as an index of building construction costs, it is, for the years involved, sufficiently representative of railway construction for practical purposes. The chief differences between a building and a railway cost index are in the greater weightings attached to steel and to common labor in the latter; and it is to be noted that both of these were high during the period of large index numbers from 1917 to 1920, while in "normal times" the two classes of construction would have substantially equal indices.

In 1921 the construction index averaged 189 and in December, 1921, it stood at 185. The building materials' index for December, 1921, was 203, while the metals index was 119 and common labor around 140 at the same time. Roughly, 25 per cent of railway cost is in grading, which is largely common labor. Track laid is about 17 per cent and is largely steel. These figures lead to the conclusion that the index of railway cost for December, 1921 is in the neighborhood of 160.

Column E shows what the actual construction would have cost had it all been done at prices which prevailed in 1913. The average of the figures in Column E for years 1904 to 1913, inclusive, is $746,000,000 per year. The differences between $746,000,000 and the figures in lower portion of Column E given in Column F, show how much railway construction has lagged behind its prewar average when both are placed on the common base of 1913 prices. Figures for 1921 are not at hand, but that year presumably had a deficiency approximately equal to that of 1920.

We have computed the deficiency in terms of 1913 prices as a matter of convenience, but when it comes to making up the deficiency in construction, current prices must be used. As stated above, the railway construction index for December, 1921, was approximately 160, and there are good reasons for believing that construction costs will not be substantially reduced in the near future. Some of these have been given in previous issues of Engineering and Contracting. On the basis of an index of 160, the cost of making up the deficiency will be not $3,092,000,000, but $4,947,000,000. These figures take no account of the requirements of the increase in population since 1913, which, if allowed for would add roughly $800,000,000 more to the deficiency.

The best estimates which we can make of what the future of railway construction should be are therefore as follows: To maintain railroad progress at its prewar level without allowance for increase of population would require annual expenditures of $746,000,000 times 1.6 or $1,194,000,000, which is $655,000,000 more than the actual expenditures of 1920. To make up the present existing deficiency in improvements in 10 years' time would require annual expenditures of $495,000,000. On this basis there should be expended during each of the succeeding 10 years a total of $1,689,000,000, or more

TABLE II—CALCULATIONS OF ANNUAL INVESTMENTS IN RAILWAY PROPERTY AND OF DEFICIENCIES BELOW NORMAL ON THE BASIS OF 1913 COSTS

Figures in columns B, C, E and F are thousands of dollars

A. Year ending June 30.	B. Investment	C. 12 months increase	D. Construction index (A.G.C.)	E. 12 months increase equated to 1913 base (C ÷ D)	F. Deficiency below average (746,000 — E)
[illegible]	[illegible]				
[illegible]	[illegible]	[illegible]	82	748,000	
[illegible]	[illegible]	[illegible]	85	696,000	
[illegible]	[illegible]	[illegible]	91	811,000	
[illegible]	[illegible]	[illegible]	97	829,000	
[illegible]	[illegible]	[illegible]	91	825,000	
[illegible]	[illegible]	[illegible]	93	425,000	
[illegible]	[illegible]	[illegible]	99	958,000	
[illegible]	[illegible]	[illegible]	98	1,075,000	
[illegible]	[illegible]	[illegible]	98	[illegible]	
[illegible]	[illegible]	[illegible]	100	581,000	
Average, [illegible]		[illegible]		746,000	
[illegible]	[illegible]	[illegible]	98	577,000	169,000
[illegible]	[illegible]	[illegible]	98	293,000	453,000
[illegible]	[illegible]	[illegible]	108	230,000	516,000
Dec. 31					
[illegible]	[illegible]	*[illegible]	108	*142,000	*231,000
[illegible]	[illegible]	[illegible]	128	572,000	174,000
[illegible]	[illegible]	[illegible]	143	287,000	459,000
[illegible]	[illegible]	[illegible]	171	184,000	562,000
[illegible]	[illegible]	[illegible]	247	218,000	528,000
Total					3,092,000

*Six months only; 12 months' increase averaged to give these figures.

TABLE III—DEFICIENCY IN PUBLIC WORKS CONSTRUCTION FOR STATES, COUNTIES AND MUNICIPALITIES

Figures in columns B, D and E are thousands of dollars

A Year	B Total [illegible]	C Relative cost index (A.G.C. index)	D Total construction equated to 1913 cost (B ÷ C)	E Deficiency below average [illegible] — D)
[illegible]	[illegible]			
[illegible]	[illegible]	[illegible]	[illegible]	113,000
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	82,000
[illegible]	[illegible]	[illegible]	[illegible]	200,000
[illegible]	[illegible]	171	[illegible]	[illegible]
[illegible]	[illegible]	247	[illegible]	77,000
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total			[illegible]	[illegible]

[illegible] report of F. W. Dodge Co.

TABLE IV—DEFICIENCY IN BUILDING CONSTRUCTION

Figures in columns B, C, E and F are thousands of dollars

A Year	B Building permits in 69 cities	C [illegible]	D. Relative building cost index (A.G.C.)	E Total building equated to 1913 cost (C ÷ D)	F Deficiency below average (1,600,000 — E)
Prewar average	....	1,600,000	100	....	....
1914	619,752	[illegible]	100	1,488,000	112,000
1915	[illegible]	[illegible]	98	[illegible]	111,000
1916	[illegible]	[illegible]	108	1,865,000	—265,000
1917	569,011	[illegible]	128	1,068,000	532,000
1918	[illegible]	[illegible]	143	578,000	1,022,000
1919	1,058,347	[illegible]	171	1,482,000	118,000
1920	1,115,154	[illegible]	247	1,082,000	518,000
1921	1,000,000	[illegible]	189	[illegible]	[illegible]
				10,624,000	2,176,000

Note.—Column B is the total value of building permits in 69 cities having 25,000,000 population in 1920. The building permits for 1921 are a close approximation. (See Statistical Abstract of the U. S., p. 276.) Since the 69 cities contain half our urban population, and since farm buildings total about 20 per cent of all other buildings in value, the total volume of all building construction is approximately 2.4 times the volume of building permits in the 69 cities.

than three times the total actually expended in 1920. The deficiency is real, but as previously stated, the prospect of its being made up at an early date is not good.

These calculations have included railway lands and equipment with other items of cost. Nevertheless, the results will stand very well as an indication of the deficiency in construction, for lands have formed no large percentage of railway costs, and equipment which is roughly 2[illegible] per cent of the total cost of all the roads in the country is largely offset by the requirements of an increased population for which no allowance has been made.

Public Works Deficiency.—There are only two statistical sources from which an estimate can be made of the total annual volume of public works construction, other than buildings—namely, the F. W. Dodge Co. data as to contracts awarded in 27 states, and the total sales of public bonds. The Bond Buyer publishes monthly totals of long-term and of short-term bonds sold by states, counties and municipalities. The long-term bond sales provide in general for the permanent improvements and are given by years in Table V.

According to the Dodge Co. the following were the totals of public works and utilities contracts awarded in 27 states:

Year	Total
1919	[illegible]
1920	[illegible]
1921	[illegible]

These 27 states contained 70 per cent of the total populations, so that if 50 per cent were added to the totals above given, the sum would approximate the total for the country, based on the Dodge Co. reports. But the Dodge Co. reports cover only cities of 3,000 or more population, so that perhaps 60 per cent should be added to the totals. Applied to the Dodge figures for 1921 this gives a total public works construction of $734,000,000, which, while a very rough estimate, is probably as close to the actual construction for the year as any figure readily determinable. Although the Dodge Co. includes some utility company contracts, the volume thereof is evidently very small.

The volume of state, county and municipal public works construction is probably given very closely by the total sales of long-term bonds, but as varying periods elapse between the sales of the bonds and the letting of the contracts, the construction for any single calendar year will not be accurately indicated by the sales of that year, nor even by the sales made during any single 12 months' period.

Obviously bonds sold near the end of the year can bring very little actual construction during that year. Although a single year's work can not be measured accurately by these means, the total of several years should be determinable with satisfactory accuracy; and as a matter of fact we find just such an agreement as might be anticipated between the F. W. Dodge Co.'s figures for 1919, 1920 and 1921, and the bonds sold during the 36 months beginning with October, 1918, and ending with September, 1921. The Dodge figures for these three calendar years multiplied by 1.6 to provide for the entire country, total $2,443,000,000, while the bonds sold during the period named total $2,351,000,000. Table V shows an excessively large volume of bond sales for the last quarter of the year, 1921, the proceeds of which obviously are to be used mainly in 1922.

The years 1909 to 1914, inclusive, give an average of $390,000,000, according to Table V. Taking this as the average prewar annual expenditure for public works, Table III gives our calculated deficiency in public works construction during the years 1915 to 1921, inclusive, as $84,000,000 on the basis of 1913 prices. We have no index of public works costs, but the railway index will approximate to it, and is sufficient for ordinary purposes. Applying the railway index of 1.6 to the above deficiency gives $134,000,000 as the total required to make up the public works at present prices.

TABLE V. SALES OF LONG TERM BONDS BY STATES, COUNTIES AND MUNICIPALITIES

(As published by "The Bond Buyer")

Year.	Total.	Year.	Total.
1906	$301,1[illegible]8,061	1914	$445,[illegible]
1907	201,[illegible]48,507	1915	492,[illegible]0,441
1908	275,384,466	1916	4[illegible]7,303,771
1909	363,6[illegible]0,786	1917	[illegible]848
1910	324,3[illegible]0,345	1918	2[illegible]2,818,844
1911	452,113,716	1919	770,195,248
1912	339,046,08[illegible]	1920	773,663,086
1913	408,477,702	1921	1,420,616,666

	1919	1920	1921	1922
January	$ 24,835,848	$ 86,637,161	$ 7[illegible]181,75[illegible]	$ 75,927,743
February	21,004,372	38,857,[illegible]	7[illegible],779	74,213,578
March	57,125,023	76,199,5[illegible]	[illegible]16	...
April	64,358,453	63,102,486	[illegible]	...
May	49,225,791	45,182,611	7[illegible]	
June	92,338,475	45,9[illegible]1,274	12[illegible]11,721	
July	75,340,360	7[illegible]44,826	[illegible]12,45[illegible]	
August	60,166,241	65,29[illegible]273	111,921,291	
September	72,787,673	70,712,508	168,16[illegible]	...
October	117,284,139	82,542,674	12[illegible]86,375	...
November	45,833,309	64,612,511	12[illegible]41,8[illegible]	...
December	89,586,091	81,556,865	1[illegible]745,[illegible]76	
Total	$770,195,248	$773,663,086	$1,420,616,66[illegible]	$150,141,321

The Aberthaw Construction Company's Index

The accompanying two diagrams were prepared by the Aberthaw Construction Company of Boston for its own use. The Cost of Building Index in Fig. 1 is explained by Mr. C. E. Patch, statistician of the company, as follows:

"As we specialize in reinforced concrete we wished an index that would follow our specialty. We therefore took a building we had constructed in New England in 1914, which was of typical design and of which we had good cost records, and using the same quantities for the various labor and material items, priced the building up at intervals, first of six months and recently of a month.

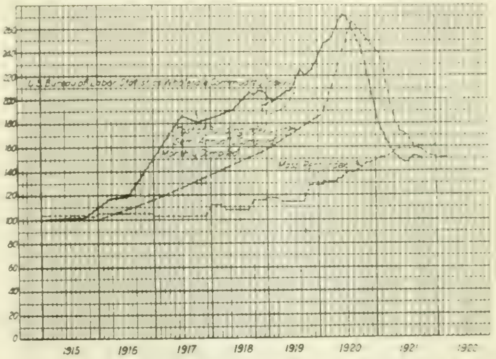


Fig. 1.—Relative Variation in Cost of Building, Rents and Wholesale Commodity Prices.

"During the period of the war, and immediately following when there was a wide spread between the price indices of the various materials entering into construction, our index would apply only to buildings of reinforced concrete. As the spread narrows down it will more nearly represent general construction. This tendency to reduce the spread is seen in the comparison of indices of construction materials in Fig. 2."

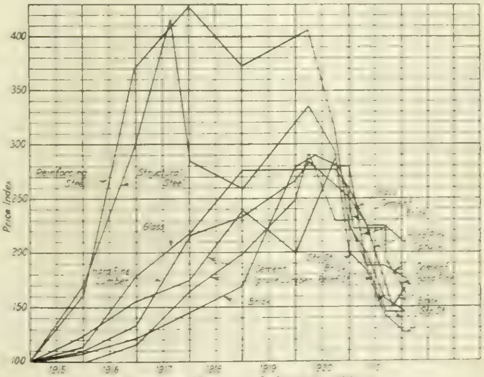


Fig. 2.—Comparison of Price Indices for Construction Materials.

Relative Cost of Building Construction for Last 9 Years

By HALBERT P. GILLETTE, Editor.

There has been no reliable index of the relative average cost of building or other construction throughout the United States. Elsewhere in this issue there is published a very recently compiled index of building costs prepared by Milan V. Ayres, statistician for the Associated General Contractors of America. This index came to my attention while I was engaged in preparing a similar index for Engineering and Contracting.

Table I gives my index in the second column, and Mr. Ayres' index in the fourth column. It gives in the fifth column the so-called "construction cost index," published by Engineering News-Record. As a check on these three indexes, I have prepared another index based on F. W. Dodge Co. statistics, which is given in the third column of Table I.

Engineering and Contracting Building Cost Index.—This index, column 2, Table I, has been calculated by adding together two Bureau of Labor indexes and dividing the sum by two, the two indexes being the "lumber building material index" and the "hourly wage index of union labor." This wage index is shown separately in column 2, Table II, and relates to all classes of union labor in 66 industrial centers. It will be observed that this wage index does not differ greatly from that for "building union wages in 8 cities" (column 3, Table II), which is the wage index used by Mr. Ayres. It is an open question whether building union wages in 8 large cities are typical of the U. S. building wages and union labor wages of all classes of workers in 66 industrial centers. During the past 5 years the wage index in column 2, Table II, has been higher than that in column 3, but if this indicates that a use of the wage index in column 2 will give a result somewhat too high, bear in mind that on the contrary building construction labor has been less efficient than normal during those years, which would probably offset any excess resulting from the use of a wage index that may be 10 per cent too high.

The best available building material index is that published monthly by the U. S. Bureau of Labor. It includes all the principal building materials except steel; but the annual output of structural steel shapes normally constitutes less than 8 per cent of the total value of other building materials. Although some steel other than "shapes" is used in building (notably reinforcing bars for concrete), this is probably offset by the quantity of "shapes" used in structures other than buildings, such as bridges. Since 8 per cent for structural "shapes" is so slight a percentage of the total value of building materials, steel may be omitted without appreciably affecting the building cost index.

As will be shown later the Engineering News-Record index is grossly in error, because structural "shapes" are "weighted" at more than 60 per cent of the total building materials!

The Associated General Contractor's building costs index gives a "weight" of 20 per cent to steel and other metals and 80 per cent to other building materials. From census statistics from 1899 I have deduced that materials constitute 60 per cent and labor 40 per cent of the reported cost of buildings. But the reported costs did not include all overhead costs, and it included none of the contractor's compensation, known as profit. Since these items vary more nearly with the labor cost than with material cost, and are of considerable magnitude, it is probably wise to include them with labor and thus arrive at a "weighting" of 50 per cent for materials and 50 per cent for labor.

The Engineering and Contracting building cost index, for reasons as above stated, gives an equal weight to labor and to building materials and it does not include steel in the building materials. The Bureau of Labor indexes for "lumber and building materials" and for "hourly wages of all unions" are added together and divided by two for the years 1913 to 1921, but thereafter an index of building labor in 20 cities will be used. This index will be published monthly hereafter, together with the labor index cost.

Cost Index Based on Dodge. The F. W. Dodge Co. does not publish a building index, but does publish data from which I have calculated the index shown in column 3, Table I. Since January, 1915, the Dodge Co. has published the number of square feet of residence and industrial (factory) buildings and the total contract price for contracts awarded in cities of more than 3,000 population in 27 northeastern states. These states are those north and east of and including North Dakota, South Dakota, Iowa, Missouri, Tennessee and Virginia, together with parts of eastern Kansas and Nebraska. Beginning May, 1921, North Carolina and South Carolina were added to the list, but with little effect upon the total. These 27 states contain 70 per cent of our entire population.

Taking the total contract value of residence buildings as given by the Dodge Co., and dividing by the total square feet, we get the results shown in Tables I and III. The cost in 1913 was not appreciably different from that in 1915, for building wages in 1915 averaged about 5 per cent more than in 1914, whereas the prices of building materials averaged about 6 per cent less, thus offsetting the rise in wages. In this estimate I am confirmed by W. W. Patton's estimate of the cost of buildings in Boston (see Engineering and Contracting, May 25, 1921).

The year 1919 was approximately normal as to the relative percentages of the 8 different classes of buildings listed by the Dodge Co., and residence buildings constituted 40 per cent of the total cost of all buildings erected in 1919 in the cities of the 27 states. Industrial buildings (factories) constituted 25 per cent of the total building cost in 1919. Table IV gives the data that I have deduced for industrial build-

TABLE I—RELATIVE BUILDING COSTS, ACCORDING TO "FOUR INDEXES."

Year	En. and Contg.	Based on Dodge	Assoc. Gen'l Contrs.	Eng. News-Record
1913	100	..	100	100
1914	100		98	93
1915	[illegible]	100	98	98
1916	104	121	108	137
1917	119	128	128	189
1918	[illegible]	160	143	[illegible]
1919	[illegible]	192	171	208
1920	[illegible]	224	247	[illegible]
1921	[illegible]	[illegible]	189	202

TABLE II—RELATIVE HOURLY WAGES.

Year.	All American unions, 66 cities.	American building unions, 8 cities.	Canadian building unions, 13 cities.
1900	[illegible]	68	.
1901	[illegible]	73	60
1902	[illegible]	77	64
1903	[illegible]	80	67
1904	[illegible]	82	70
1905	[illegible]	84	73
1906	[illegible]	87	77
1907	[illegible]	92	80
1908	[illegible]	94	82
1909	[illegible]	95	83
1910	[illegible]	96	87
1911	[illegible]	97	90
1912	97	[illegible]	96
1913	100	100	100
1914	102	101	101
1915	[illegible]	103	102
1916	107	104	102
1917	111	109	110
1918	[illegible]	122	126
1919	155	146	148
1920	199	188	181
1921	205	187	...
Dec., 1921	..	183	...

Note—The relative wage for "all unions" is from the U. S. Bureau of Labor and relates to all union labor in the U. S. The relative wage for American "building unions" relates only to 11 building trades in 8 cities.

TABLE III—RELATIVE COST OF RESIDENCE BUILDINGS IN 27 STATES (BASED ON DODGE CO. STATISTICS).

Year.	Monthly average	Cost per sq. ft.	Relative cost.
1915	[illegible]	$1.83	100
1916	[illegible]	2.21	121
1917	[illegible]	2.35	128
1918	[illegible]	2.93	160
1919	[illegible]	3.51	192
1920	[illegible]	4.11	224
1921	[illegible]	4.29	235
1921—			
January	[illegible]	4.57	250
February	36,291,000	4.36	238
March	[illegible]	4.22	231
April	[illegible]	4.18	228
May	[illegible]	4.11	241
June	[illegible]	4.12	225
July	[illegible]	4.32	236
August	[illegible]	4.48	245
September	[illegible]	4.39	240
October	[illegible]	4.08	223
November	[illegible]	3.98	218
December	[illegible]	4.60	251
1922—			
January	75,728,000	4.19	229

TABLE IV.—RELATIVE COST OF INDUSTRIAL (FACTORY) BUILDINGS (BASED ON DODGE CO. STATISTICS)

Year	Monthly average	Cost per sq. ft.	Relative cost
[illegible]	$ 8,8[illegible],000	[illegible]	100
[illegible]	15,2[illegible],000	[illegible]	[illegible]
[illegible]	20,6[illegible],000	[illegible]	[illegible]
[illegible]	10,[illegible],000	[illegible]	[illegible]
[illegible]	12,4[illegible],000	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	14,1[illegible],000	[illegible]	[illegible]
1921			
January	16,4[illegible],000	[illegible]	[illegible]
February	[illegible]	[illegible]	[illegible]
March	[illegible]	[illegible]	[illegible]
April	12,[illegible],000	[illegible]	220
May	20,[illegible],000	[illegible]	[illegible]
June	18,[illegible],000	[illegible]	[illegible]
July	[illegible]	[illegible]	[illegible]
August	[illegible]	[illegible]	[illegible]
September	11,28[illegible],000	[illegible]	[illegible]
October	18,[illegible],000	[illegible]	[illegible]
November	17,6[illegible],000	[illegible]	[illegible]
December	14,[illegible],000	5.12	305
1922			
January	19,6[illegible],000	[illegible]	[illegible]

TABLE V.—BUILDING COSTS IN 27 STATES (BASED ON DODGE CO. STATISTICS)

Monthly average.

Class of buildings	(Thousands of dollars.) 1919	1920	1921	Cost per sq. ft. 1919	1920	1921
Business	$ [illegible]	$ 2[illegible],63[illegible]	$ 27,66[illegible]	[illegible]	[illegible]	[illegible]
Industrial	12,7[illegible]	1[illegible],080	14,44[illegible]	[illegible]	[illegible]	[illegible]
Residential	[illegible]	47,177	73,1[illegible]	[illegible]	[illegible]	[illegible]
Educational	[illegible]	14,258	20,81[illegible]	7.20	[illegible]	[illegible]
Hospitals	[illegible]	[illegible],962	5,845	[illegible]	[illegible]	[illegible]
Public	[illegible]	2,218	1,8[illegible]	[illegible]	[illegible]	[illegible]
Recreational	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Religious	[illegible],127	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total and av.	$7[illegible],15[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

ings, in a manner corresponding to the deducted results in Table III. It will be noted that the volume of industrial building construction was abnormally low in 1915 and in 1921, which probably makes the costs per square foot in those two years unreliable; for when the volume of construction of a given class of building varies greatly from normal, there is no assurance that the buildings erected will be typical of their class.

Table V gives data as to all classes of buildings, deduced, as above indicated, from the Dodge Co. statistics.

Although the cost index based on the Dodge square foot costs is not entirely satisfactory, it has the merit of reflecting changes in efficiency of labor, and of being based on retail prices of building materials in 27 states. Were it not for wide variations in the quantity of building contracts awarded in different cities, this index would probably be the best of all. The monthly changes, as shown in Table III, are quite erratic, due to variations in the volume and type of residence buildings in different cities.

Associated General Contractors Cost Index.—This is a new building cost index published elsewhere in this issue. It is based on the two wholesale price indexes of "lumber and building materials" and of "metals," published by the Bureau of Labor, and on building wages in 8 cities. "Lumber and building materials" are given a "weight" of 2, and "metals" a weight of 1. Then the materials index thus derived is given a weight of 6, and wages a weight of 4. Cost of all metals (in which steel predominates but in which copper is a large factor) does not enter into building construction in any such large percentage as the 20 per cent assigned to it in this index.

The Associated General Contractors' index for December, 1921, is 185.

Engineering News-Record Cost Index.—This "construction cost index" purports to give a relative average cost of all kinds of construction, including buildings. Since public works construction constitutes normally about 20 per cent of combined building and public works, this index should reflect building costs predominately. As a matter of fact, it is worthless, whether as an index of all construction or of building construction. This worthlessness arises not only from the fact that prices of only three materials in three cities are used, but from the fact that steel is given a "weight" about 10 times what it should receive. If the price of steel followed closely the price of other materials, this gross error in "weighting" would be immaterial, but steel prices have a habit of fluctuating in a manner seldom corresponding closely with other building materials, and frequently out of all relation with other material prices. This has been noticeably the case during recent years. Hence it was a foregone conclusion that the Engineering News-Record construction cost index would agree with no other index. To make matters worse, the wages used in this index (up to 1921) are those for common labor in the steel industry, which have also moved in recent years far out of step with construction wages. Moreover, common labor constitutes only about 10 per cent of all labor on buildings, and an unknown percentage on the average of all other construction. So both as to the "weighting" of steel and as to the rates of wages, this index could hardly have been worse. The three materials used in this index are (1) Base price of structural shapes at Pittsburgh, (2) cement (exclusive of bags) at Chicago, and (3) southern pine at New York. Estimators who have a wide experience need not be told that the prices of only three construction materials in but three cities will not give a reasonably close average for the entire country, either for building construction or for all construction combined. Nor is the common labor-wage in the steel mills a fair index of construction wages, especially during years of rapid changes in steel mill output. The steel mills raised wages more rapidly and to a greater extent than construction wages were raised during 1916 to 1918, and conversely, they lowered them more markedly in 1921. Since December, 1920, Engineering News-Record has used the average common labor wage in 20 cities, and this is obviously far preferable to the steel mill wage of common laborers; but it still leaves much to be desired, for union building wages have not moved in unison with common labor during the past seven years. Common labor wages rose far more rapidly than building artisan wages during the war, and their fall during the past year has been as spectacular as their rise. The elements in Engineering News-Record construction index are improperly weighted, except as to labor. Labor constitutes about 40 per cent of the total, and this is substantially correct for buildings. It is questionable whether anyone knows what would be a correct average percentage for labor of all construction combined. It is true that labor enters into all materials, and, if Prof. King is correct, about 75 per cent of all income goes to brain and manual workers, the other 25 per cent going to capital as interest, rent, etc. But the question that concerns us in this problem is what percentage of the cost of all construction is the cost of labor? As yet no one has published an analytical study of this problem. In another article in this issue I have given the average percentage of labor cost in building construction, but not for other classes of construction.

Engineering News-Record weighted the four elements in its construction index for 1913 as follows:

	Per cent.
Structural steel	38
Cement	7
Lumber (pine)	17
Labor	38
Total	100

A study of the relative weight given the different classes of building materials by the U. S. Bureau of Labor, in the compilation of its index numbers for building materials, brings out both the erroneous weighting and the incompleteness of the list of materials in the construction cost index compiled by Engineering News-Record.

Special Building Cost Indexes.—Several cost indexes relating to some one type of building are available, notably the indexes of Aberthaw, Fuller and Patten. The Aberthaw index is given in another article in this issue. The Patten index was published in Engineering and Contracting May 25, 1921; and it is hoped to bring it down to date in a later issue. A special index of this sort is published in Gillette and Dana's handbook of "Mechanical and Electrical Cost Data," page 173. There is great need of many more similar special cost indexes, not only for different types of buildings, but for different cities.

Changes in Efficiency of Workers and Designs.—In this connection it should be remembered that no existing building cost index reflects either changes in efficiency of labor or improvement in the design of buildings.

In concrete buildings there has been a notable increase in the output of the average building workman during the past 15 or 20 years, ascribable to the use of more economic machinery, forms, etc. There has also been a marked improvement in design.

In frame houses there has been a decided lowering of the labor cost on those houses where "mill framed" lumber is used. The use of standard sizes framed at the mill instead of being framed by carpenters, is one of the means by which efficiency of labor in construction has been increased in many instances.

The building trades have been relatively slow, however, in adopting improved methods of construction, partly because of the prevalent ignorance of builders, and partly because of the opposition of labor unions to labor saving methods. There is therefore a great opportunity for reduction in building costs even though building wages remain unchanged.

Manufacturers of building materials have not been asleep during the past few years, and some decided reductions in cost of production have been effected. One of the most striking of the recent improvements is the production of hollow bricks. To meet the competition of other classes of building materials, many brick manufacturers are now making hollow bricks that are not hollow tile. This is an advance in the art that is just beginning to make itself felt. Such advances are not reflected in building cost indexes.

Changes in Union Wage Scales, 1907 to 1921

The change that has taken place between 1907 and 1921 in the union scale of wages and hours of labor, all trades taken as a whole, is shown in the following table of index numbers taken from a bulletin of the U. S. Bureau of Labor Statistics on "Changes in Union Wage Scales 1907 to 1921." These index numbers are simply percentages in which 1913 is taken as the base or 100. The figures are as of May each year, not yearly averages.

Between 1907 and 1921 there was an increase in the index number from 90 to 205, making the rate per hour in 1921 nearly 2¼ times that of 1907. In studying the table it must be kept in mind that the figures are not money rates or hours of labor, but index numbers computed from such rates and hours. The detailed data for 1921 and further summary figures for earlier years will appear in a forthcoming bulletin.

The index numbers are based on the union minimum rates as provided in agreements with employers. In some instances individual employees are paid more than the union scale. The investigation covers the principal trades paid at "time" rates in 66 large industrial centers. Employees working at piece rates can not be included, as there are many different piece rates in some trades, and piece rates are seldom intelligible to anyone outside of the trade in question. Average earnings per hour or week at piece rates involve so much labor that the collection and compilation of such information could not be undertaken in connection with the present work.

The table follows:

INDEX NUMBERS OF UNION WAGE RATES AND HOURS OF LABOR IN THE UNITED STATES AS OF MAY EACH YEAR 1907 TO 1921
(1913 = 100.)

Year	Rates of wages per hour	Full-time hours per week	Rates of wages per week, full time
1907	90	103	92
1908	91	102	93
1909	92	102	93
1910	94	101	95
1911	96	101	96
1912	98	100	98
1913	100	100	100
1914	102	100	102
1915	103	99	102
1916	107	99	106
1917	114	98	112
1918	133	97	130
1919	155	95	148
1920	199	94	189
1921	205	94	193

Effect of Heat Treatment on the Mechanical Properties of 1 Per Cent Carbon Steel.—Technologic Paper No. 206 of the Bureau of Standards on the "Effect of Heat Treatment on the Mechanical Properties of 1 Per Cent Carbon Steel" will be ready for distribution by the Superintendent of Documents, Government Printing Office, Washington, D. C., during March. The price is 15 ct. per copy. This paper gives the effects of varying time temperature relations in heat treatment on tensile and impact properties, hardness, and structure of 1 per cent carbon steel, as follows: (a) Effect of temperature variations in hardening; (b) time of hardening temperatures above Acm between the Ac1 and Acm transformation; (c) effects of tempering steels hardened in different ways and effects of "soaking" just under the lower critical range, and (d) comparison of oil and water hardening for production of definite strengths. Under the described conditions of treatment and test, the features observed are described in detail under their headings.

The Ratio of Labor to Materials Cost in Buildings

By HALBERT P. GILLETTE, Editor.

The recent publication of some wild estimates of the magnitude of the building industry calls attention to the fact that many engineers do not have accurate knowledge of the relation between labor and material costs on buildings. In the U. S. census for 1899 will be found the only extensive data from which this relation can be calculated. While it is true that there are many published details of the cost of labor and materials for different types of buildings, who knows what percentage of each type ordinarily enters into the total of all types? In frame buildings the labor cost is a much higher percentage than in steel and brick buildings. Who knows the average for all buildings erected in a normal year?

From the census for 1899 the following data may be derived for all buildings erected in that year:

Materials	[illegible]
Labor and profit	[illegible]
Total	[illegible]

The "profit" includes the proprietary supervision of the contractor and his expenses other than wages and salaries. If we estimate this "profit" to have been 10 per cent of the total, we deduce the following percentages:

Material	[illegible]
Wages and salaries	[illegible]
"Profit"	10
Total percentage	100

To this should be added the cost of architecture and engineering. By the building contractors who reported to the census in 1899 (see manufacturing statistics), there were employed 593,000 men, but all men engaged in the building trades were 1,212,000, which seems to indicate that about half the total number of building workers were engaged by companies or individuals not specializing in building. Probably nearly all such workers were engaged on maintenance and small additions or changes.

The following were the classes of men in the building trades in 1899 and 1909, also the total number of people "engaged in gainful occupations," and the total population:

	1899.	1909.
	Thousands	
Carpenters and joiners	600	830
Masons	161	204
Painters	277	341
Paperhangers	22	26
Plasterers	36	51
Plumbers	98	168
Roofers	9	[illegible]
Others	9	26
Total building trades	1,212	1,661
Total, gainful occupations	29,073	38,167
Total population	74,318	90,557

Apparently few common laborers are classed under building trades. In our issue of Feb. 22, a table was given showing the percentage of labor cost for every class of labor on the average frame building and on the average brick building. Common labor constituted 6.3 per cent of the labor cost of a frame building and 9.9 per cent of a brick building. If we call the general average for all buildings 7.5 per cent and if we estimate the day's wages of common labor at 60 per cent that of skilled labor, it would follow that about 12.5 per cent of the number of building workers are common laborers. From this it would appear that about 12 per cent should be added to the census totals of building trade workers to include common laborers. If this is done, it will be seen that less than 5 per cent of the total number of people engaged in gainful occupations were engaged directly on the construction and maintenance of buildings. Since the ratio of cost of labor to materials on buildings is normally about 4 to 5, it would seem to follow that approximately 6 per cent of the total number of all workers are normally engaged in producing and delivering materials for buildings. But it would be erroneous to add the 6 to the 5 per cent to get the total percentage of workers engaged directly and indirectly in the building trades; for, as above indicated, about half the building trade workers are normally engaged on maintenance and small job improvements and alterations. Men engaged on such work use relatively small amounts of new material. I estimate roughly that instead of 6 we should add about 4 to the 5 per cent, making a total of 9 per cent of all workers normally engaged directly and indirectly in constructing and maintaining buildings.

Index Numbers of Wholesale Prices 1913 to February 1922

The accompanying tabulation shows the index number of wholesale prices by groups of commodities, as computed by the U. S. Bureau of Labor Statistics. The group of miscellaneous commodities includes such important articles as cottonseed meal and oil, lubricating oil, jute, rubber, newsprint and wrapping paper, rope, soap, laundry, starch, tobacco, Manila hemp, sisal, phosphate rock and wood pulp. The commodities, composing the other groups, are as indicated by the title:

INDEX NUMBERS OF WHOLESALE PRICES IN SPECIFIED YEARS AND MONTHS, 1913 TO FEBRUARY 1922, BY GROUPS OF COMMODITIES
(1913—100.)

Year and month.	Farm products.	Food, etc.	Cloths and clothing.	Fuel and lighting.	Metals and metal products.	Building materials.	Chemicals and drugs.	House-furnishing goods.	Miscellaneous.	All commodities.
1913	100	100	100	100	100	100	100	100	100	100
Jan.	97	99	100	103	107	100	101	100	100	100
Apr.	97	96	100	98	102	101	101	100	[illegible]	98
July	101	101	100	99	98	101	99	100	101	100
Oct.	103	102	100	100	99	98	100	100	100	101
1914	103	103	98	96	87	97	101	[illegible]	[illegible]	100
Jan.	101	102	98	99	92	98	100	99	[illegible]	100
April	103	95	99	98	91	99	100	99	101	98
July	104	104	99	95	85	97	99	[illegible]	97	100
Oct.	103	107	97	93	83	96	[illegible]	[illegible]	96	99
1915	105	104	100	93	97	94	114	[illegible]	99	101
Jan.	102	106	96	93	83	94	103	99	100	99
Apr.	107	105	99	89	91	94	102	99	99	100
July	108	104	99	90	102	93	108	[illegible]	98	101
Oct.	105	103	103	96	100	93	124	99	99	101
1916	122	126	128	119	148	101	159	115	120	124
Jan.	108	113	110	105	126	99	150	105	107	110
Apr.	114	117	119	108	147	101	172	108	110	117
July	118	121	126	108	145	99	176	121	120	119
Oct.	136	140	138	133	151	101	150	124	132	134
1917	189	176	181	175	208	124	198	144	155	176
Jan.	148	150	161	176	183	106	159	132	138	151
April	181	182	169	184	208	114	170	139	140	172
July	199	181	187	192	257	132	198	152	173	186
Oct.	198	183	193	146	182	114	252	152	193	181
1918	220	189	239	163	181	151	221	196	193	196
Jan.	207	187	211	157	174	136	232	161	178	185
April	217	178	232	157	177	146	229	172	111	190
July	224	184	249	166	184	154	216	199	190	198
Oct.	224	201	257	167	187	158	218	226	196	204
1919	234	210	261	173	161	192	179	236	217	212
Jan.	222	207	234	170	172	161	191	218	212	203
April	235	211	217	167	152	162	178	217	216	203
July	246	216	282	171	158	186	171	245	221	218
Oct.	230	211	313	181	161	231	174	264	220	223
1920	218	236	302	238	186	308	210	366	236	243
Jan.	246	253	350	184	177	268	189	324	227	248
Feb.	237	244	356	187	189	300	187	329	227	249
March	239	246	356	192	192	324	205	329	230	253
April	246	270	353	213	195	341	212	321	238	265
May	244	287	347	235	193	341	215	329	246	272
June	243	279	335	246	190	337	218	362	247	269
July	236	268	317	252	191	333	217	362	243	262
Aug.	222	235	290	268	193	328	216	363	240	250
Sept.	210	222	273	284	192	318	222	371	239	242
Oct.	182	204	257	282	184	313	316	371	229	225
Nov.	165	195	234	258	170	274	207	369	220	207
Dec.	144	172	220	236	157	266	188	346	205	189
1921:										
Jan.	136	162	208	228	152	239	183	282	190	177
Feb.	129	150	198	218	146	222	178	277	180	167
March	125	150	192	207	139	208	171	275	167	162
April	115	141	186	199	138	203	168	274	154	154
May	117	133	181	194	138	202	166	262	151	151
June	113	132	180	187	132	202	166	250	150	148
July	115	134	179	184	125	200	163	[illegible]	144	148
Aug.	118	152	179	182	120	198	161	250	147	152
Sept.	122	146	187	178	120	[illegible]	[illegible]	223	146	152
Oct.	119	142	190	182	121	192	162	218	145	150
Nov.	114	142	186	186	119	197	162	218	145	149
Dec.	113	139	185	187	119	203	161	218	148	149
1922:										
Jan.	116	134	183	183	117	202	159	214	146	148
Feb.	126	138	183	183	115	202	159	213	150	151

Bridge Building in Indiana.—The 1922 bridge program of the Indiana State Highway Department provides for the construction of 107 bridges at a cost of about $2,290,000. The federal government will share half of the cost of 65 of the structures, which will cost approximately $1,917,000. The state alone will build 39 structures to cost about $373,000. William J. Titus, chief bridge engineer for the department, will have general supervision of the program.

The Accumulated Deficiency in Building Construction and the Building Outlook

The following is an abstract of an address by Leonard P. Ayres, vice-president of the Cleveland Trust Co., at the last annual meeting (Jan. 17) of the Associated General Contractors.

The recovery of the construction industry is the first, the most potent, and perhaps the most important sign of a recovery from a period of depression.

Such a recovery has begun to take place now, and we watch it with the very closest scrutiny because we are enormously interested, more than we would be in the same amount of recovery in any other industry.

I have tried to find out how much recovery in construction is occurring. Each one of those black upright columns on this chart (Fig. 1) represents in millions of dollars the amount of building permits in the 20 leading American cities each year over the past 21 years. They are rather low in the period of hard times, the panic of 1903-1904. They come up sharply in the period of prosperity that followed. They fell off again in the period of 1907-1908; responded again to the prosperity of 1909 and the steady prosperity of 1910, 1911 and 1912, going down again in the hard times of 1913 and 1914 and then recovered.

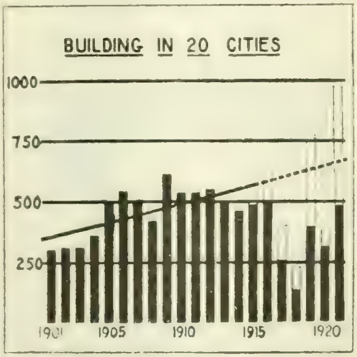


Fig. 1.

Here on the chart (Fig. 1) are some columns partly solid, partly in outline. The first prominent one is for the year 1916 and a lower one, 1917, and a very little one, 1918. An enormous recovery is shown in 1919, a bad period in 1920 and a very great amount of money spent on construction in 1921. These last columns, partly solid and partly in outline, represent in their entire height the total amount of money spent. That building, however, was very expensive building and the money spent did not measure the amount of building actually done in the same sense it did in earlier years, so I divided through by the increased cost of that construction each year and it shrinks these columns down to the part that is in black. The black portions show on the same basis as for the earlier years how much construction was actually done.

Then I said, "Now, let's find out how this business of construction in our cities is growing from year to year." So I had drawn through this diagram from the starting point at the left over to 1915 the slanting straight line. That represents (over the first part of the period) the general trend of construction, that was increasing as these cities grew in population. It is not drawn through by guess work or by pulling a string across the upright columns or by any such method, but by the method of least squares, which gives us a line that a mathematician would describe as representing more accurately than could any other straight line that might be drawn the general trend of these irregularly rising columns. I continued it on up over the last abnormal period and we can fairly say that it is the normal line.

We may say that in these first four bad years, building was below normal. Then it shot up very much above normal and made up the deficiency. In the hard times of 1908 it fell below normal and then again it shot up and stayed up considerably above. It went down in 1913 and 1914 and was coming up when the war came on, then we have this irregular process further on. Building responds very sensitively to these changes in business conditions. It is very depressed or it is very active.

The construction industry is either frigid or torrid, and on the chart you see it swinging from one stage into the other, and so if we have our normal line as we have shown on the chart, we may measure the degree of the torridity and the frigidity and find out how great is the shortage or how much ahead of the natural, normal requirements in the community the thing is.

I may say I doubted a bit whether this was fully reliable and made the same computation from the Bradstreet figures covering 120 cities instead of 20 cities, and within a few fractional points, it checked out. So I took the straight slanting line and I made it into a horizontal line right across this chart (Fig. 2) and put below the deficiencies and above the surpluses and above normal by quarters instead of by whole years. Twenty, in 1902, means 20 per cent below normal in that year, 30 per cent below in 1903 and so on. Twenty in 1905-6 means 20 per cent above normal and the horizontal line is simply that slanting straight line on the other sheet that I have turned around until it is level.

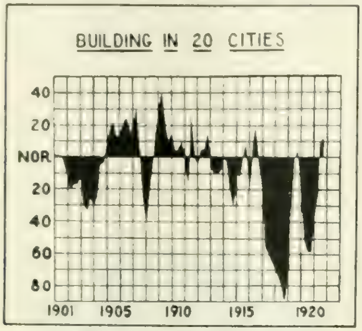


Fig. 2.

Construction in 20 Leading Cities.—So here we have the story of the construction industry in these 20 leading American cities, a deficiency of building in 1901 and 1902 and 1903 and 1904, a very quick recovery catching up with the deficiency and going ahead, and activities above normal in 1905 and 1906 and the first part of 1907, the panic of 1907-1908, almost a stoppage of construction, a quick recovery and back to the prosperity of 1909. Then several years, you remember them well, when we didn't have very prosperous times and we didn't have any more panics or depressions, and construction, like other business, went along fluctuating above and below normal over quite a span of time.

Then we came into this period of restricted building that came with the Great War. The Government came into it and down, down it went until we got down to 1918, almost to a suspension of city building, where at the low point we were about 96 per cent or 98 per cent below normal, down almost to nothing. A brief recovery in 1919, and a very great depression again in 1920, and then the rapid recovery which has carried us up to about 11 per cent above normal on the basis of the last data that has come in.

So we have here a mirror showing how construction has been fluctuating over a quarter of a century.

I took those figures and said, "How far ahead or behind the game are we?" Because that is the answer that I was trying to get at—to see how the size-up of this industry would turn out. And here (see Fig. 3), I have a curved line showing the accumulated results of the previous chart.

Building Deficiency to Date.—If you put all these deficiencies together and then add the surpluses and subtract deficiencies again, what happens? We were even with the game when we started. We ran into those hard times of 1901 to 1904 and accumulated a deficiency of building in 20 cities amounting to more than one half year's construction. Prosperity came and we cut down that shortage and we got it nearly back to normal when the panic of 1907-1908 came along, curtailed the building and the shortage came up again. In 1909 construction went ahead rapidly, the shortage was cut down until we got to normal and ahead of it and began to get a little overbuilt, and many of you can remember those years in which our city buildings were hunting for tenants. It ran along up to 1914, until in 1915 and 1916 a little shortage developed, and then 1917, 1918, 1919 and 1920, one year, two years, two and a quarter, well along toward two and a half years of shortage of building in our American cities, and I think that it will turn out to be about that figure, whether you measure it by these 20 cities or whether you take 120 cities.

It is not true for the country districts insofar as I can find out, but in city buildings that in general is the condition, and we have turned the corner and started to cut the deficiency down with the active building operations the last few months.

Ten Years Needed to Eliminate Shortage.—Let us assume that that series of computations is roughly right, and I think we may do that. What does it mean? It means that this industry, if it has ahead of it a shortage amounting to two and a quarter years of construction, is in a condition where, if we have anything resembling normal business, it can go ahead for nine years at 25 per cent above normal for the whole time.

It is not going to do that, for various other reasons, but that shortage is there. Most of it is a shortage that has to be made up—not all, because in some measure, if you use a building longer than you normally would use it, that deficiency does not have to be made up. The suit of clothes that I have on has done a year's more service than normal and I will never have to make it up. I have saved that year. But that is not equally true of buildings, for populations grow and they require more and more buildings and this normal is a very real thing. If we grow with that rapidity, it happens to our clothes, too, by the way.

No other industry has any such condition confronting it. That fact constitutes an opportunity that ought, if properly managed, to turn out to be one very nearly unparalleled in our current economic situation.

Conditions Ripe for Much Construction.—The construction industry thus enters a period of great accumulated shortage at a time when interest rates have fallen far, far below what they were and when the difficulties and problems of financing are rapidly disappearing—so rapidly that my own expectation is that within six months most of the acrimonious discussions that you and we have indulged in will be at an end. Thus I think the problems of financing are largely ended because money is easy and seeking investment, prices have come down to a relative stability, a shortage exists.

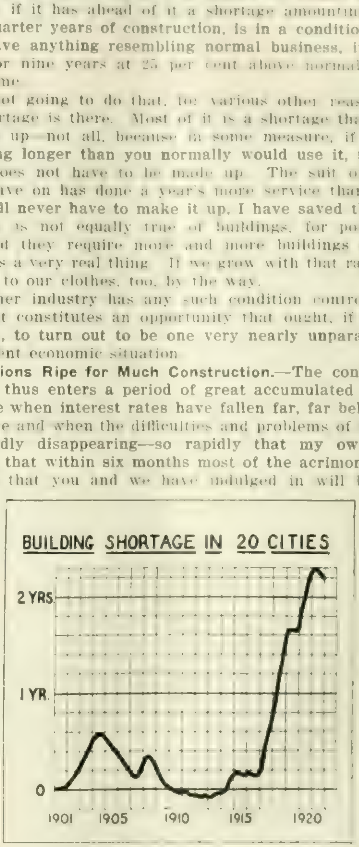


Fig. 3.

Those are the three factors which are necessary and present for increased activity in the building industry. We are entering this era at a time when your industry, like every other industry, is going to find that its problem is one of more efficient management and of delivering to the buyer a large value for the dollar he has given.

For business men in this period of competition are going to demand value, they are going to shop when they make their purchases in construction just as they are in every other commodity. That man, who can hand over to them a large inherent worth for the investment, is the man who is going to reap his reward in this competitive period that is upon us.

How Local Engineering Societies Can Serve the Public

Comments on Suggestions in Editorial in Feb. 22 Issue of Engineering and Contracting

Engineer Must Get Over His Aversion to Politics.

My belief is that a great drawback in engineering is the fact that engineers have not assumed themselves to be political leaders. Lawyers believe that they may enter either political life or the practice of law. As a consequence, they feel themselves prepared to enter politics. The engineer's training is with physical laws and their application to engineering. As a usual proposition an engineering student does not consider politics as his field at all.

The Knoxville Technical Society, which includes engineers, architects and others engaged in scientific pursuits, is undertaking to become a factor in the community life. The effort has been heretofore to study problems which directly concern the general community. I believe that the club can do a considerable service along this line.

Before the engineer can become a real factor in politics, his aversion for politics must be removed. Few real engineers are willing to accept positions which are political appointments,

N. W. DOUGHERTY,
Professor of Civil Engineering, University of Tennessee, Knoxville, Tenn.

Engineers Should Call Attention to Questionable Civic Practices.

It does seem to me that the one and first thing needful is that engineers become active in calling attention to questionable civic practices. Both chapters and individual members can call the public's attention to errors about to be committed. I do not think that they should engage in any activity in the matter of financing investigations and research which their criticism naturally would provoke, for any suggestion in connection with the criticism or advocacy of a course of wisdom in civic matters, to finance an investigation, at once detracts from the position taken by the engineer. It senses the idea of the creation of a job.

If the engineers will make clear their rightful position in public matters from time to time as they arise, the mere work of investigation and report will take care of itself. The trouble now is that the engineers do not take upon themselves the burden of voluntary suggestions. They allow such matters to spring from the ministers and lawyers. As a result the engineer is left out of consideration when somebody is engaged for pay to do the investigating, usually a person wholly incompetent for the job. As it stands now, regardless of what influences it, the facts are that the engineer, individually and collectively, but seldom allows his voice to be heard. If this characteristic is encouraged by professional ethics it is a mistake and ought to be corrected. A man should allow himself to be heard if in the nature of his training he becomes qualified to speak.

WILL P. BLAIR,
President Cleveland Chapter American Association of Engineers, Cleveland, O.

Education as a Means for Overcoming Shortcomings of Average Engineer.

I have read your editorial on Public Service by Engineering Societies with a great deal of interest, and am glad to have the opportunity of making a few suggestions. I don't want to be regarded as opposing the proposition, but I do want to make a few brutally frank remarks about the average engineer.

So much has been said lately about the leadership which an engineer should step into, because of his training. It seems to me that right here is the weakness. Every other professional man is obliged to get a general cultural education before he is admitted to any high class professional school. The engineer is taken fresh from high school, crammed full of mathematics and other technical stuff, and sent out into the world, a walking slide rule. He knows figures, but he doesn't know men. He can design a bridge, but he cannot write a paper about it that is worth reading. Remember, I speak of the average engineer, not the exception. He can figure the cost of a road, and he can build it, but he can't talk a crowd into voting the bonds for the job. In other words, his training has never fitted him to meet life. It has trained him to meet details only.

Now to be more cheerful. Many of the chapters of A. A. E are getting into public life more and more. Stumblingly and hesitatingly, it is true, but they are getting there. The Boise Chapter, A. A. E., recently voted to co-operate with the different commercial organizations in finding a road up to Table Rock. They went so far as to suggest that surveys be furnished free, but I stepped on that proposition. Public service is a fine thing, but they were shutting out their own members from possible fees, and heaven knows that the practicing engineer in Idaho gets few enough fees lately. The Astoria Chapter went out in a body and made a free survey for a city park. That may have been all right, but I feel that their public service should have consisted of giving professional advice and in finding whether the scheme was practicable, and then left the actual surveying to some practicing engineer. Our brother professions do much public service, but they do not volunteer to do free work to top it off.

The whole thing boils down to education. Insist that the engineer be properly prepared to meet life as it is, even though he be not quite so heavily loaded with mathematics and formulae, and the poor chap will take his rightful place in the scheme of things as they are, not as they ought to be.

Boise, Idaho. E. F. AYRES.

Public Service Plan of St. Louis Societies.

I have read the editorial in your issue of Feb. 22, 1922, headed "How Local Engineering Societies and Chapters Serve the Public." It is my personal opinion that the success of any definite method such as suggested would be doubtful. I might give you just briefly the plan used in St. Louis where we have an active association of engineering societies with a membership of approximately 850, as well as an Engineers' Club, of which the writer is also president.

Our joint regulations provide that all matters affecting public interest can only be passed upon by the various local societies acting as a unit through their joint council. A Public Affairs Committee is one of our standing committees which investigates various projects of a public nature and reports to the Joint Council, which in turn may recommend adoption of such a report. This committee is composed of engineers of standing in the community, most of whom have had experience in public affairs and who, furthermore, are willing to give some time to the work. No attempt is made to draw up any detail engineering recommendations relative to any particular matter, but recommendations of an engineering nature which may be advocated are studied by this committee with considerable care, after which action is taken as described above.

This plan has worked very nicely and the viewpoint of the engineering societies is often sought on engineering matters of public interest, and public and city officials are more and more looking to our body for suggestions and advice. This is, perhaps, reflected in the fact that newspapers usually give rather freely of their space for write-ups of meetings on engineering topics of public interest.

The campaign you suggest would certainly prove of value and the question really is as to just how to bring the desired results about.

W. E. BRYAN,
President Joint Council, St. Louis, Mo.

The Engineer as a Political Leader.

How can the engineer become a political leader? By co-operation. Let all engineers combine to be recognized as members of a profession, changing the present order, wherein he is usually regarded as a higher class of laborer. Do away with present conditions whereby public engineers, municipal, county, state and federal, are appointed by a miscellaneous board of officials few, if any, of whom usually are conversant with even the rudimentary necessities or requirements of the work to be performed, but who after a short tenure of office and by virtue of same pose as experts before their constituents and, generally speaking, are upheld as such by the daily press. Having control of funds they desire absolute control.

Another desirable change would be for the railroad companies to recognize engineers as professionals, instead of a necessary evil; employ only qualified engineers, at commenstate pay, thereby probably decreasing their expenditures, since properly trained, qualified men would save money by increased ability and fewer errors.

When the time comes that the engineer shall be able to direct instead of taking orders from some superior non-technical official, public or private, when he shall be able to plan and execute as an engineer to "produce," untrammelled by politics or policies, then the engineer will as a matter of course take his position as a leader of men, on equal footing with members of other professions, and probably leading these because of his greater technical knowledge of public requirements.

Lake Worth, Fla. C. E. GARNETT.

Citizen Engineer Program for Indianapolis.

The Indianapolis Chapter of the American Association of Engineers was organized in 1918 with 20 members. A policy was adopted of meeting regularly each week for luncheon from 12:15 to 1:30 with no program except discussion of civic affairs.

The attendance for the first few months averaged four or five, but has now grown to 45 to 55, and the membership of the Chapter is 250. Very little preparation of programs is necessary; the meetings run themselves.

As a result of these discussions this Chapter has now adopted a plan of civic activities which is stated as follows:

The citizen engineer program for Indianapolis recommends:

1. Making Sewerage System Complete.
2. Continued Track Elevation.
3. Completed Flood Protection.
4. Completed Memorial Project.
5. Modernized Street Lighting.
6. Improved Traffic Arteries.
7. Paving Built-Up Streets.
8. Regulated Local Transportation.
9. Restricted Smoke Nuisance.
10. Investigation of Centralized Water Softening.

Ten committees have been appointed, one for each of these activities, and each committee is chargeable with accomplishing something under its heading with the advice and approval of the Chapter as expressed at its weekly luncheons.

Such activities almost necessarily lead to studies of economic problems and I have found myself much influenced by civic affairs to give consideration to questions of political economy; I believe other members of the Chapter have been similarly influenced.

DANIEL B. LUTEN.

Indianapolis, Ind.

The Engineer Should Enter Politics.

While we agree in principal with the editorial appearing in "Engineering and Contracting" for Feb. 22, we cannot believe the methods set forth represent the best way of applying our thought and effort to the problem at hand.

Here in Colorado we are slowly but surely coming to the conclusion that it is best to abandon the high sounding phrases of political service, civic interest, and the like, and come down to face our problem as merely one of getting into politics. We do not believe it possible for engineers, no matter how high they may stand in their own opinion, to exert any marked and continued influence in controlling public policy unless the rank and file of the profession are going to shoulder their burden and actually become interested in the manipulation of local political machinery. Please do not misunderstand this statement to mean that engineers should lower themselves to the level of our present political methods. Rather the young engineer trained to scientific thought would enter politics with the vowed purpose of raising political standards and with the public weal foremost in purpose.

It will be readily admitted that our municipal, state, and national governments would be vastly better off if engineering methods were pursued in their conduct, and especially in the conduct of public work that is allotted to them. We believe this consummation cannot be brought about except by the diligent and concentrated interest and activity of the profession in all government affairs, not in an academic but in a practical way. It would seem, therefore, to be the duty of local engineering and technical organizations to encourage their membership to learn their political A B C's. The Colorado Society of Engineers is taking this point of view and our members, both young and old, are encouraged to attend political primaries of their precinct or district. We want to see more of our members in the State Legislature, more on the various commissions and boards whose influence reach to the actual management of public affairs.

Our Civic Affairs Committee is to prepare a roster this year of the officers, time, and place of meeting of all local improvement associations and civic clubs, and it is expected to furnish speakers for these local bodies on subjects of interest to them that involve engineering.

In conclusion, I believe any means of approach of this most important matter that will get results is good. We are willing to start at the beginning and attack the problem in a scientific way. We believe there is nothing mysterious about the conduct of the government and nothing that will not yield to engineering methods if right be the ultimate object and truth prevail in its attainment.

C. M. LIGHTBURN,
Secretary Colorado Society of Engineers, Denver, Colo.

Los Angeles Society Studies Economic Problems of Locality.

It is true that "Engineers lack time and money for public service" and many investigations and recommendations might be made on economic problems if local engineering societies could co-operate with other local organizations who perhaps have the funds but not the talent.

In our Los Angeles section, as you know, we have been very vitally interested in the economic problems of the region. We have spent much time on the study of flood control problems, the conservation of our water resources, the development of power, and last but not least the local sewer problem and the railroad terminal situation. We find difficulty of course in making our conclusions reach the general public. The Municipal League and other civic organizations with money at their command are able to present their ideas to a large body of the public, and co-operation with bodies of this kind would probably make our local section of more value than it has been in the general life of the community.

RALPH J. REED,
President Los Angeles Section Am. Soc. C. E.
Los Angeles, Calif.

How Local Engineering Club Has Benefitted City.

The suggestions of the editorial are in line with the work that the Engineering Club of Sioux City has been doing for some time. A recent incident is of interest. The club volunteered their services to the city in the way of giving advice and succeeded in saving several hundred dollars a month in reduction of electric power costs. The company supplying power operates the street car system here. An arrangement was made whereby the city would not run its pumps during the evening rush hours for the cars. The service company made a substantial reduction in rates for this.

I could recite a number of other instances where the club had benefitted the city in similar ways.

JOHN D. ADAMS,
Secretary Sioux City Chapter A. E. E., Sioux City, Ia.

To Place Engineers in the Legislature.

At the 43rd annual convention held in Kalamazoo Feb. 8th to 10th inclusive, the topic, "How Local Engineering Societies and Chapters Can Serve the Public," was given a great deal of discussion and the following resolution carried unanimously:

RESOLVED, That a Public Service Committee be appointed, whose duty it shall be to place as many engineers into this year's legislature as possible and to encourage the individual chapters to have engineers available, in their community, become members of the legislative body, of their respective communities.

Another important matter taken up at this time was the urging of engineers to become city managers.

I deem your article both timely and important and rest assured that the Michigan Engineering Society, State Assembly of the American Association of Engineers, heartily endorse the idea of placing the engineer where he should be in leadership in governmental works and all matters of public service.

C. B. HUFF,
Secretary Michigan Engineering Society, State Assembly, A. A. E., Detroit, Mich.

Engineering Club as Clearing House for Engineering Problems.

We are at the present time working along the lines of establishing some definite connection between the various civic organizations. This will operate to make the engineering club the clearing house for all matters involving engineering problems. It will also place these matters in the hands of those best qualified to take care of same.

MONROE L. PATZIG

The Engineer Must Place Himself Before the Public.

The feature acting most to retard the advancement of the engineer in the community is his error in believing the public should come to him for advice and help. It is characteristic of the American people to act on their own responsibility and rely upon their own judgment and resources. This means that the engineer while basically, probably, the best trained man in the community to lead in enterprises of a public nature is not appreciated and remains uncalled on for the aid and co-operation which he could so efficiently give.

The public will not seek the individual but rather is it necessary that the individual (the engineer) place himself before the public in such capacities that his presence and help will always be an established certainty. This condition I believe will only come about by the continuous effort of the engineer himself.

With added prestige the engineer may well organize the bodies you mention in your letter but little has been done thus far in this community. It is a pleasure to realize others are taking the matter up.

E. E. MIX.
Long Beach, Calif.

What a North Carolina Society Is Doing.

The North Carolina Society of Engineers, of which I am vice president, has a legislative committee. It was largely through the work of this committee that an engineer's license law was enacted by the 1921 General Assembly. This committee is now working for the establishment of an engineering experiment station, and for the adoption of uniform traffic rules for the entire state. The local engineering society, of which I am president, has investigated the regulation of traffic in Raleigh, and has a committee appointed to study the water situation and report on what might be done for its improvement. There are many other civic problems which we propose to take up and discuss at subsequent meetings.

I really believe that the licensing of engineers will enable them to co-operate with one another better than they have in the past. I am not an advocate of the licensing of engineers as a CURE-ALL; but I do believe in the next ten years the engineering profession will greatly profit through such laws. Some suggestion has been made that the status of the engineering profession might be raised through the adoption of a CODE OF ETHICS. The trouble is, a code of ethics will not reach the engineer who desires to violate such a code. In this state the majority of engineers are those who are engineers in name only; who have not even a high school education. It is necessary that we require higher standards for the engineer to enter the profession. Engineering license laws will give us a means of enforcing certain requirements.

HARRY TUCKER,
Professor of Highway Engineering, North Carolina State College of Agriculture and Engineering, Raleigh, N. C.

Engineers Must Make Legislatures Appreciate Practical Value of Engineering.

Referring to the editorial in Engineering and Contracting, of Feb. 22nd, in which you recommend a study of ways and means of launching a campaign for securing funds with which to make local investigations of economic problems and to convey the results to the people.

This is really the duty of the State Legislature. The legislature has the funds with which they can make investigations as suggested in the editorial, and so have the Chamber of Commerce and other such societies, but it is the duty of the engineer to get these organizations to appreciate the practical value of engineering, so that they will seek and pay for engineering advice. Engineers must gain the attentions of these bodies and their appreciation by actions that ring out in a manner that demands attention, even as the sting of a bee. Such work is probably the chief purpose of the A. A. E.

State investigations, as well as congressional investigations, are numerous. The results, however, are in some instances negligible; in other cases some small change is noticed. Take for example the investigations in the cost of coal. Whenever one occurs, the newspapers are almost certain to comment: "Congress to investigate the high cost of coal; now watch the price advance."

Investigations will bring about the desired results when the public appreciates that engineers are educated and trained in this direction, and makes use of them. That day will be when the public demands legislatures to make use of the services of engineers, and compensate them accordingly.

FREDERICK O. LEWIS,
Secretary Boston Chapter A. A. E., Boston, Mass.

Nashville Engineers Taking Up Civic Problems.

The engineers of Nashville are taking up civic problems in the meetings of the engineering associations. The conclusions reached after thorough committee investigation and discussion in meeting are embodied in recommendations presented to the city council, which realizes the value of the service the engineers can render them, and on occasion has requested that a representative of the engineers appear before a meeting of the council and instruct them on a particular question.

This is work along the right lines and should be fostered, as engineers gain more experience in public appearance and confidence in themselves it will be increasingly easy to utilize them for public service.

WM. S. WHITMAN,
Secretary Nashville Chapter, A. A. E., Nashville, Tenn.

Development of Natural Resources Local Problem.

I read portions of the editorial from your Feb. 22 issue at the last meeting of the Columbia Chapter of A. A. E. It provoked considerable discussion. It may be that some time in the future we may be able to develop this idea further. It requires men of large caliber and considerable public spirit and a great deal of energy to work at the idea expressed in your editorial.

Our local problems appear to me to be concerned with efforts to develop our natural resources. The water power possibilities at Columbia are about 50 per cent developed. There is a great need for drainage reclamation work in the lower half of our state. The engineers should take the lead in these matters, but I do not know how soon they can be made to see it.

L. M. FISHER,
Columbia, S. C.

Serves the Public Without Becoming Politically Involved.

Under the direction of our Program Committee we are endeavoring to serve the public without becoming politically involved, except to such an extent as it may mean taking a definite stand on what the Engineers' Club considers the right side from an economic and engineering point of view.

Our club last season, through a definitely appointed committee, conducted a careful investigation of the question of a water softening plant for softening our entire city water supply, which under present conditions carries an extremely high degree of hardness. The committee put some months to careful investigation of this matter and made a report favoring the water softening system. At such time as this can be brought to an issue in the city, the Engineers' Club will take a definite stand for the water softening plant.

The club expects next to interest itself in the problem of city planning and civic center work, and is intending to make itself heard on various questions of civic welfare. Our activities in this field are as yet young and we can not therefore give a report of any practical results obtained.

HARRY I. SCHENCK,
Recording Secretary the Engineers' Club of Dayton,
Dayton, O.

Two Great Fields for American Capital

A year ago the ratio of gold to Federal Reserve Bank deposits and notes was 46 per cent. It is now 73 per cent. This is the result of a general slackening in business activity, and it has brought about a great reduction in interest rates. Capital therefore is eagerly seeking safe investment.

In recent articles in the North American Review, C. Reinold Noyes shows that during the next 25 years there is likely to be a large surplus of capital seeking investment. After reviewing the investment field he comes to the conclusion that there are two fields that promise the best safe returns, namely (1) The production of new commodities or services, and (2) public and semi-public works and housing. Although our readers are mainly concerned with the second field, we think it advisable to quote Mr. Noyes' conclusions as to each of these two great fields:

"But there are two other fields to which I wish to direct special attention, for they seem, under the new conditions, to be the ideal types of investment.

"Of these the first is the production of new commodities or means for the satisfaction of new human wants; devices attainable to the generality of men, for which the market will be additional to all present demand. Instead of devoting the increase of manufacturing energy to competing for the limited demand for old products, instead of pouring more goods into already saturated markets, it is quite possible to develop additions to the standard of living for which a new demand will spring up. We have already done much of this. The automobile, the phonograph, the moving picture and the sewing machine are examples which come to mind. These articles were not to any large degree replacements. They were new products. Their development has caused concern among those who conceived them as evidences of national extravagance. They did not perceive that the creation of anything that is wanted creates at the same time the purchasing power to pay for it. Surplus economic energy can find no better employment than in addition to the equipment of the consumer. If part of our population can make enough of the natural home commodities to supply all of us and maintain our desirable exports, then the rest can much better contribute new articles to the general welfare than either to over-produce in lines already saturated, or attempt to provide those things which the rest of the world is ready to give us in payment for our exports and their debt.

"Material progress is associated with an improving standard of living and the goal is a happier and more progressive people. Mere quantity of production—mere productivity—is an outworn fetish. New kinds of production, the development and exploitation of new inventions, should be encouraged and receive more general financial backing. If successful, these ventures are always the most profitable. One feels that he is not talking into deaf ears when he preaches this doctrine to Americans.

"The last field of investment is decidedly the largest of all and is the one par excellence which under present conditions should receive the great bulk of new capital. This is the fixed capital devoted to the production of services to our people as distinguished from the production of commodities. It consists principally of public works, public utilities and housing. At least half of the total invested capital of the United States is at the present time included in this classification.

"This is a crude new land. Away from the relatively narrow limits of industrial settlements the face of nature has been little touched. The country is still frontier by comparison with the man-made countryside of older and more thickly settled Europe. We have been too busy with our beginnings to develop, in the short space of a hundred years, the finished product of a land arranged for man. We need waterways, hydro-electric developments, reforestation, roads and parks. The public works are not developed on the initiative of private capital though they are commonly financed by municipal bonds. Undoubtedly these projects can and will use large quantities of our savings, and officials should be encouraged to make wise expenditures for these purposes. As long as such bonds remain tax-free there will need to be no further incentive to secure all the capital that can safely be used for this purpose.

"With the public utilities the case is, of course, different. They have been starved for ten years and are far behind their normal development. This is particularly true of the railroads, but somewhat true of other classes as well. With the coming of lower costs and saner regulation it is to be hoped that the credit of the public utilities in the market place may be re-established, so that they can secure a large share of the new capital available for investment, increase their facilities, and improve their efficiency both by the introduction of new devices and the judicious replacement of old.

"Finally, there is the housing problem. And this field I particularly wish to emphasize because, while it is the largest single type of investment of the people as a whole, it has been singularly and perhaps unfortunately free from the application of funds upon a wholesale scale. It is an enormous and ideal field for investment, particularly favored under the new conditions. Yet it has been, and is now, left largely to individual and retail handling.

"Our housing is not nearly sufficient, nor suitable to the requirements or means of our people. The buildings are not permanent as in Europe, but are too generally cheap, temporary structures, because they are built as 'tax-payers' or on the very limited means of the home-builder. The business of erection and of financing the homes of the people is usually handled on a small local scale. There is no open market for mortgages on residence property. These are matters for individual transaction, privately arranged. And the result is that investment in first and second mortgage loans and the ownership of renting residence property is so troublesome that the average investor cannot be tempted to touch it. Perhaps one of the reasons for the development of the apartment house has been the readiness with which it lent itself to a more business-like and large-scale handling.

"As a general rule housing has not been considered a field for big financial operations. Some of the Western trust companies are already engaged in the residence mortgage business. The savings banks and insurance companies invest extensively in first mortgages on such buildings. But there is need for big operating and big financing corporations to develop this field. The risk of loans on standard housing developments is far less than upon specialty or one-use buildings, and the profits are big. A system of bond issues based on mortgages on assorted risks could undoubtedly be made a success.

"It is, of course, utterly foolish that the outcry against the profiteering landlord should be permitted to take the course of harassing and restrictive legislation. What is needed is legislative encouragement and popular favor so as to attract investors into this field, not to drive them out as is now being done. Proposed federal legislation seems to indicate a change of sentiment in this regard."

$58,000,000 Insurance Co. Money for Housing Construction

Fifty-eight million dollars has been loaned by the Metropolitan Life Insurance Co. throughout the United States to build homes and apartments.

The Chicago Trust Co., handling the loans for the Metropolitan company in Illinois, Wisconsin and Northern Indiana, announces that in that territory $3,400,000 of the fund has been spread sufficiently to build 1,040 homes and apartments, while new buildings are now going up at the rate of 30 a month. These houses have been erected in 66 cities.

The unusual part of the plan, according to the banking officials, is the small average of each loan, which is said to indicate that the construction is done for small home builders. The Illinois loans average about $4,000 each, which is approximately half the value of building and lot in each case. The builders are given three to fifteen years in which to repay the loans.

The banking officials state that the Metropolitan company does about as much clerical work in making one of these small loans as it would in putting out the entire $60,000,000 in a few big loans, and that the large loan policy is the one usually favored by American companies with vast sums to invest.

Building Cost Index of the Associated General Contractors

[The following article and diagram are taken from "Index," a statistical service for the construction industry, published by the Associated General Contractors of America, and copyrighted by them in 1922. Tables III and IV and the explanations of the various weightings used in the compilation were not a part of the original article, but were furnished on request by Mr. Milan V. Ayres, statistician of the Associated General Contractors. This index was first calculated under the direction of Col. Leonard P. Ayres, Vice-President of the Cleveland Trust Co., and is now maintained by Milan V. Ayres, Statistician.—Editor Engineering and Contracting.]

Apparently it costs about two and one-half times as much to put up an average building now as it did in 1900. This is in spite of the fact that the cost of building has come down 30 per cent since it reached its peak in May, 1920.

The diagram shows the fluctuations, month by month, in the cost of building during the past 22 years, the cost of building materials, and the cost of building wages. The index of material prices is a composite of two indices published by the Department of Labor, namely: (a) Lumber and building materials, and (b) metals and metal products. The wage index is a composite of the wages prevailing in eleven of the building trades including common labor, for eight principal cities of the country. The result may be described as a general index of building costs for the entire country.

Wages increased at a nearly uniform rate from the beginning of 1900 until the end of 1916. The general tendency of material costs during the same period was upwards, but with a good many fluctuations. For more than a year after the outbreak of the European War, they remained lower than the average for the four previous years. In the fall of 1915 they started up and reached a maximum in 1920, very much higher than the maximum index figure for wages. The combined figure for the cost of building reached its maximum in May, 1920, at 263 per cent of the 1913 average. It dropped to a low figure of 180 last September and has started up again, reaching 185 in December. This increase during the three closing months of the past year was due entirely to rising costs of materials, as wages remained substantially constant.

The indications seem to be that the prices of building materials will, in general, hold up to their present level or perhaps slightly increase, during the next few months, and it seems improbable that any general or wide-spread wage reduction will take place, so the prospects are against any general reduction in building costs for some time to come.

Apparently no attempts were made anywhere to establish indices of building costs until the high prices resulting from the war caused men to question the wisdom of putting their money into building enterprises. Prior to that time the nearest thing there was to a building cost index was the Bureau of Labor figure on the wholesale price of lumber and building materials. This is a material price only, however, and does not properly cover the building field, principally for the reason that it excludes all metal.

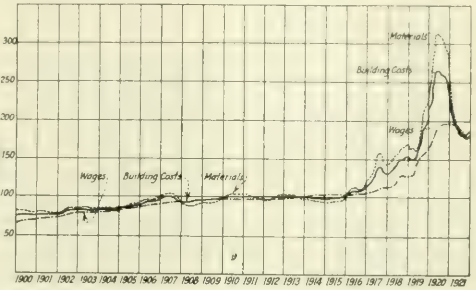


Diagram Showing the Average Cost of Building Construction in Terms of 100 Per Cent as the Average for the Year 1913.

There are now available a number of construction cost indices which have been computed back through the war period. Six of these are compared as to certain of their features in Table I. These are as follows:

A. General Construction. This is the Engineering News Record's Construction Cost Index, and is supposed to repre-

TABLE I. SIX INDICES OF THE COST OF BUILDING COMPARED.

Type of Construction.	Cost in per cent of 1913 cost Max., 1920.	Nov., 1921.	Dec., 1921
A. General construction	274	166	168
B. Concrete factory	265	154	153
C. General building	263	182	184
D. Loft building	221	166	
E. Office building	215	162	..
F Hotel building	213	164	...

TABLE II. COST OF BUILDING INDEX.

(Average cost in 1913 equals 100.)

	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921
January	74	75	76	81	83	82	90	96	93	93	97	100	96	100	98	96	104	115	131	119	218	211
February	75	75	76	82	82	83	91	97	92	93	98	100	96	101	99	97	105	117	133	150	237	202
March	76	76	77	82	82	83	91	98	92	92	98	100	96	101	99	97	107	119	136	150	251	194
April	76	76	78	82	82	84	92	98	92	92	98	100	96	101	99	97	108	122	137	148	261	191
May	75	76	79	81	82	84	92	98	91	92	98	99	97	101	98	98	109	125	140	153	263	189
June	76	76	80	82	83	86	92	98	90	92	99	97	97	100	98	98	108	133	143	162	261	186
July	75	77	80	81	83	85	93	98	90	92	100	97	98	100	98	98	107	138	146	169	260	184
August	75	77	81	81	82	87	92	98	90	93	100	96	98	99	98	97	107	138	148	181	258	183
September	74	76	81	82	81	87	93	97	90	91	100	97	99	99	97	97	108	136	150	191	253	180
October	74	78	81	82	81	88	94	96	91	94	100	96	99	99	97	98	109	131	150	193	250	180
November	75	78	81	82	81	89	94	95	91	96	100	96	100	99	96	99	111	130	152	197	230	182
December	75	76	81	82	82	88	95	93	93	96	100	96	100	98	96	101	115	131	152	208	224	185
Average	75	76	79	82	82	86	92	97	91	93	99	98	98	100	98	98	108	128	143	171	247	189

TABLE III.—BUILDING MATERIALS INDEX.

(Average cost in 1913 equals 100.)

	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921
January	81	78	76	82	83	81	92	100	93	92	98	100	96	101	97	92	104	121	144	163	270	222
February	82	78	78	84	83	83	94	101	93	92	109	102	95	102	98	93	106	124	146	161	278	207
March	82	79	78	84	82	83	94	102	91	91	109	102	95	101	98	93	109	128	150	164	298	194
April	82	80	79	83	82	84	94	103	91	91	100	103	96	101	97	93	110	133	152	160	312	190
May	81	79	82	82	83	85	94	103	89	91	100	100	97	101	96	94	112	137	154	161	311	189
June	81	79	82	83	84	88	94	102	88	90	101	98	97	101	96	94	111	149	156	171	308	188
July	79	80	82	82	83	86	95	102	87	90	102	98	98	100	95	95	118	157	160	180	305	185
August	79	80	83	81	82	88	95	101	88	92	102	96	99	99	95	94	119	156	163	199	301	182
September	77	79	83	82	80	89	96	100	88	94	102	97	100	99	94	94	110	152	164	214	293	178
October	78	80	83	82	80	90	96	98	89	94	102	96	100	98	93	94	111	144	164	217	287	178
November	79	81	83	83	80	91	97	97	89	96	102	96	100	98	92	96	115	142	169	222	253	181
December	79	77	83	82	81	90	99	93	92	97	102	95	100	97	92	100	122	143	168	236	244	186
Average	80	79	81	83	82	86	95	100	90	92	101	98	98	100	95	94	111	141	157	188	287	190

TABLE IV.—BUILDING WAGE INDEX

(Average Wages in 1913 equal 100.)

	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921
January	65	70	71	79	82	83	86	91	93	94	95	96	97	99	109	102	103	105	113	128	170	185
February	65	71	75	79	82	83	87	91	93	94	95	96	97	99	100	102	103	106	113	128	175	195
March	66	71	75	80	82	83	87	92	93	94	95	96	97	99	101	102	103	106	114	128	180	195
April	67	71	76	80	82	84	88	92	93	94	96	96	97	100	101	103	104	107	115	130	185	192
May	67	72	76	80	82	84	88	92	94	94	96	96	97	100	101	103	104	108	119	140	190	189
June	68	72	76	80	82	84	88	92	94	94	96	96	97	100	102	103	104	109	123	150	191	184
July	69	72	77	81	82	84	89	92	94	95	96	96	97	100	102	103	105	110	125	152	192	183
August	69	72	77	81	82	84	89	92	94	95	96	97	98	100	102	103	105	111	127	173	193	183
September	69	73	78	81	83	85	90	93	94	95	96	97	98	100	102	103	105	112	128	176	194	183
October	70	73	79	81	83	85	90	93	94	95	96	97	98	100	102	103	105	113	128	157	195	183
November	70	74	78	81	83	86	90	93	94	95	96	97	98	100	102	103	105	113	128	160	195	183
December	70	74	78	82	83	86	90	93	94	95	96	97	99	100	102	103	105	113	128	165	195	183
Average	68	72	76	80	82	84	89	92	94	95	96	96	97	100	101	103	104	109	122	146	188	187

[illegible] construction of all kinds, not merely building, for the country as a whole.

B. Concrete Factory. This is the Aberthaw Company's Construction Cost Index and represents the estimated cost of building a particular factory of fireproof reinforced concrete type in the neighborhood of Boston.

C. General Building. This is the building cost index shown in the diagram and has already been sufficiently described.

D. Loft Building. This is the estimated cost of constructing a particular loft building in New York City.

E. Office Building. This is the estimated cost of constructing a particular office building in New York City.

F. Hotel Building. This is the estimated cost of constructing a particular hotel building in New York City (by George A. Fuller Co.)

The recent values of four out of these six indices are very close together, figures for November ranging from 162 to [illegible]. The concrete factory index is considerably lower at [illegible] and the general building index considerably higher at [illegible]. Some of the reasons for the differences in the present value of these indices appear to be the following: Item C, general building, is the only one which includes a sufficient amount of lumber to be fairly representative of general building. All of the others include large amounts of steel, which is now at a comparatively low price, and small amounts of lumber, which is high priced. In the computation of Item A, Engineering News Record Index, steel is given 2.2 times the weight of lumber and 5.[illegible] times the weight of cement. This seems to us to give steel far too much relative importance to represent general construction.

Items D, E and F relate to modern steel frame building in which, of course, that metal properly plays a very important part. This probably accounts for the fact that the maximum figures for these three indices are so much below the maximum of the other three. Steel did not go nearly so high during 1920 as most other materials.

Weightings Used in the Compilation.—In computing the Material Index, the item "lumber and building materials" was given a weight of four, and the item of "metal and metal products" was given the weight of one.

In compiling the Wage Index, the eleven building trades used were grouped in two classes, one of eight under the heading of artisans, and one of three under the heading of laborers. The artisans include the following: Bricklayers, carpenters, cement finishers, inside wiremen, painters, plasterers, plumbers and structural iron workers. The laborers include: Laborers, plasterers' helpers, and hod carriers. The wages of each group were averaged without weighting, and the two groups were then combined on the basis of giving the artisans a weight of two, and laborers a weight of one.

An unweighted average of the eight trades given as in the artisan class, would be seriously in error were it not for the fact that the prevailing wages in these eight trades are so nearly alike that the plain average is without doubt, very nearly the same as would result from the most careful weighting. The same observation applies with substantial accuracy to the case of the three trades put in the class of laborers.

In the General Building Cost Index a weight of 2 was assigned to wages and a weight of 3 to materials.

The cities involved are: Boston, Los Angeles, Louisville, New York, St. Louis, Washington, Cleveland and Chicago.

The fact that the eight cities are given equal weights in compilation of the wage data may seem open to criticism, but it is probable that the unweighted average in this case is as good as any result which would be arrived at by any system of weighting. If the cities were weighted on the basis of population or on volume of building, or number of artisans employed, the result would be to give an altogether undue predominance to New York City.

To Standardize Practice in Highway Bridge Design.—Greater standardization of practice in the design and construction of highway bridges is urged by the Bureau of Public Roads of the United States Department of Agriculture. A "Standard of Practice" is being prepared, which will represent the best thought on the subject and which it is believed will be accepted by all the State highway departments.

How to Increase Output of Building Trades Workers

Methods of Securing Greater Production Described in Address at Annual Meeting of Associated General Contractors

By SANFORD E. THOMPSON,
Consulting Engineer, Boston, Mass.

Getting right down to fundamentals: is not the trouble in the first place the lack of appreciation by the workers of the necessity for doing a good day's work in order to maintain a good day's pay, and, even further than that, the actual belief on the part of many of the workers that it is incumbent upon them to work slowly in order to make the work go around?

Assuming that these are fundamental causes of restriction, they must be counteracted in three ways: (1) by education, which involves a considerable period devoted to the teaching of fundamental economic principles, (2) by the establishment of some plan of inducing the workmen to greater production, and (3) by the determination of actual time standards so that the employer will know just how much work a man ought to accomplish for a fair day's work, taking into account the variations and conditions that occur.

We believe the thinking leaders of labor today really appreciate the necessity for eliminating restriction of output, although actions are not always in accord with this point of view.

Planning and Controlling Substituted for Drive Methods. In the factory, for the "drive" method which reacted toward slowing production, is being substituted more definite methods of planning and controlling the work done with more intimate knowledge of what a man can do, how much can best be done, and in what sequence. In other words, method is being substituted for brute force. This definite control and knowledge of what is being done makes it possible to give incentives to the men—financial and, in some cases, non-financial.

As an illustration, take an Ohio rubber plant employing largely unskilled labor. It was found by better planning of the sequence of operations, thorough analysis of the operations themselves, and rearrangement of the gangs that it was possible to increase the output per man some 40 per cent. After about three months' work of studying conditions, analyzing and changing the methods without changing machinery, it was possible to bring the men up to increased production, notwithstanding the fact that they were working on a bonus before. This was done with scarcely any changes in machinery, but by the development of methods

You say that factory work is different from construction; that they have the same men month after month and year after year; that the processes are routine instead of changing from job to job. The best answer to this is that similar results have been accomplished in construction work and as successfully as in the factory.

Cost Halved by Scientific Methods.—On one concrete construction job, by the use of what might be termed scientific methods, the "making" of the forms for a 6-story concrete building 600 ft. long by 200 ft. wide was done at practically one-half the cost of the same work formerly handled by the same construction company under the old methods, and this notwithstanding the fact that under the old methods they had made a detailed study of their costs for several years to reduce them as low as possible. The saving then was due directly to the application of the more scientific methods.

In house construction similar results have been produced. In one case where scientific methods were installed by a residential building company and the carpenter work laid out so as to give definite jobs to each man, with a liberal reward for accomplishment, two buildings out of a group of twenty about to be constructed, no two of which were alike, were selected to compare work by day labor with that handled by scientific management methods.

On these two houses all the carpenter work was handled by straight day labor and the carpenter foreman selected for the job was the most experienced foreman in the employ of the company; in fact, he formerly had sub-contracted for this work at low cost. The other eighteen houses were built by improved methods of management, the carpenters being paid a bonus for accomplishing the work laid out for them in the required manner and time. On the houses built by the ordinary day-work methods, the increased cost of the work over that obtained on the other [illegible] houses with the improved methods was as follows:

Setting of first floor joists cost 78 per cent more than with improved methods.

Erecting first floor curtain walls cost 26 per cent more than with improved methods.

Erecting second floor curtain walls cost 16 per cent more than with improved methods.

Erecting first floor sub-floor cost 54 per cent more than with improved methods.

Erecting second floor sub-floor cost 59 per cent more than with improved methods.

In the work of common laborers, such as trenching and backfilling for sewers and water pipe, large reductions in cost have also been effected. For example, in a case where the digging was of an exceptionally hard and varied character, being a very stiff, tenacious clay, the following results were obtained:

Operation.	Unit cost ordinary methods.	Unit cost [illegible] methods.
Excavation	48.0 ct. per cu. yd	31.8 ct. per cu. yd.
Pipe laying	11.1 ct. per lin. ft	[illegible] ct. per lin. ft
Back filling	34.6 ct. per cu. yd	[illegible] ct. per cu. yd

These results have not been due, as might be thought at first sight, simply to requiring the workman to do two or three times the amount of work he formerly accomplished, but, in a large degree, to thorough planning of the work in advance, studying the actual details of the work and teaching men how to perform their tasks in the easiest possible manner.

Essential Features of Waste Elimination.—The savings, then, were obtained not by merely hustling the work nor in any degree by slighting it, but to much more essential features of:

(a) Economical design and layout of construction operations.

()b Laying out in advance the method of handling the work to reduce to a minimum the quantity of construction material.

(c) Selection of the best tools and materials.

(d) Arranging the processes to simplify the work and teaching the men how to do it in the best way.

(e) Designating in advance the amount of work to be done by each man.

(f) Giving the men a definite money incentive to encourage them to do a large day's work.

(g) Eliminating the time ordinarily lost by workmen, such as waiting for orders, waiting for foremen to lay out the work, waiting for materials, looking up tools, using improper tools.

An important feature of the plan developed was the payment of bonuses for accomplishment of the different pieces of work in the standard times estimated in advance. These standards were obtained by job analyses carried on similar to factory studies. In other cases, where bonus or piece work was impracticable, it has been found possible to attain similar results by the establishment of standard times for performance and keeping track of the actual time consumed by the men. Here it is necessary to allow, of course, a longer time as a standard than if done with an incentive and interesting the men to keep up these standards.

Task and Bonus Method.—As illustration of the results in house construction that I have spoken of, I have here some 35 or 40 sheets. They are photographs of the original sheets used in working up the studies and figuring the standard times, that is: the times in which men should handle the work under task and bonus, as we call it, standard time and bonus is a better term, working under the good conditions.

These cover the labor of such work as framing the lumber, erecting the partitions, putting in the bridging, laying the floors, setting the windows, casing the doors and actually doing the trim in the house—that is, the base boards and the chair rails and the other work of the trim. Perhaps just a word as to the way that is possible, because those of you who are not familiar with that class of work may not appreciate just how it is done. Suppose, for example, we take this floor. Any of you, of course, appreciate the fact that it would take a great deal less time per square foot to lay the center of this floor than for a small room, where there is a lot of cutting at the end and a lot of corners.

On the other hand, take this room over the corner where the plaster sticks out and you have four exterior angles and four interior angles around that pilaster, you have extra time there.

Now, we find, by taking the same method that you use in factory work in figuring up piece rates, by time-study method, that if you take on a floor (and that is what these figures show) the time per square foot and then take the time per linear foot at the end of the room and the time per linear foot at the side of the room and the time per corner, take those individually and then make the combinations for the different sizes of rooms, you get something that is adaptable to any size of room and you can figure it up accurately.

These figures that I show are not theoretical nor academic, but have actually been used in the building of a large number of dwellings with the savings of cost that I have indicated a few minutes ago.

Figures on Bricklaying. I have here also one table, which is one of quite a number, showing the average number of brick that a man lays on different kinds of walls when working under ordinary contract conditions. These are pre-war figures, and they are made up by methods similar to those I have just described.

The principal interest in them is relative. For example, just to read a few of the items, for common brick nicely laid with common bond, the relative figures for building a brick wall 12 in. thick are 1,140 bricks per day of eight hours. For a 32 in. wall the number of brick would be 1,655.

Now, I will come down to a curved wall with occasional openings, and for a 12-in. wall it comes down to 895 bricks. For selected face or water-struck brick, facing a blank wall, 625 bricks a day; city house fronts having circular bay windows, 280. Those are simply figures picked out at random from this table, and, as I said, they are worked up from unit times taken in the way that I have spoken of. I simply give this to show how such things can be done. They also show the possibilities of expanding and developing them.

We have in our files data of that kind on earth work and concreting and plastering and slating and sewer bricklaying; they present a large opportunity for increased output and reduced cost during coming years. Such data, however, cannot be adopted offhand. It would not do any good to have me give you these figures just as they are. This, perhaps, can best be illustrated by reference to the case of the rubber plant referred to a few minutes ago.

..**Output Increased 40 Per Cent.**—Before getting this 40 per cent increase in output per man, the methods of handling the work had to be worked out to see that the jobs were properly distributed to the men, that the materials came to the men at the right time, that the condition of the material was workable, that the quality was right and that conditions in general permitted the workmen to do an exceptional day's work.

This required detail analysis of conditions by special men trained in analytical study and the establishment of methods somewhat different in principle from those that had been used. In the house construction referred to, it was found that the making up of framing plans reduced the labor on the job; that, by sawing the lumber at the mill for the sills, studs, joists and rafters, not only time but a considerable amount of material could be saved; that by planning out the work, something as in a modern factory, that the jobs were dovetailed into each other and lost time was eliminated; that by figuring out in advance the time required for each operation and then paying a bonus for its accomplishment the men had a definite incentive to do their best work.

In other cases where it was impracticable to pay a bonus on account of union or other conditions, by the determination in advance of the time, allowing, as I have already said for less strenuous work than where a bonus is paid, similar results were possible. Even to get the advantage of standards of this kind, however, it is necessary to provide definite methods for controlling and in keeping track of the work. It means increased overhead; it means more clerical work. But who can object, for example, to pay $25 for clerks, if by so doing he is able to save $100 in skilled labor and, at the same time, increase the speed of the job to a marked degree? That is what we all want to think of; not whether we've got two extra men on the job, but whether those men are making money for us by saving money somewhere else

I feel there is a large development possible in this kind of work in construction.

Co-operation of Unions Necessary.—Such development requires the co-operation of the individual workman. Unless contaminated by outside parties this is easily obtained, but it must be worked out so as to make it advantageous for him to co-operate. With union labor, to attain the most complete results, the co-operation of the union must be obtained. Many unions are appreciating the necessity for standardization and of accumulation of facts in order to lay out and carry on work to better advantage. Even, however, without the co-operation of the union a great deal can be accomplished along the lines indicated above.

In undertaking the development of more effective methods, the viewpoint of the worker must be considered, particularly from the standpoint of eliminating the causes of irritation due to lack of proper materials, tools and equipment, waiting for work after on the job, and, particularly, the irregularity of employment throughout the year. The last, perhaps more than anything else, is a source of endless worry to the workingman. I was unable to get here this morning, but I think that part of the subject has been treated quite ably, to judge from the program.

Increased Pay to Offset Laffoffs. In the building trades skilled and unskilled workers are actually employed from 60 per cent to 80 per cent of the time. This means not merely that nearly every workman is looking forward with dread to the day when his job is finished, but it means, also, that the employer is paying in actual wages from 25 per cent to 66 per cent more per day for his labor than if the men could work continuously. Did you ever think of that? If a man worked 60 per cent of the year, as some of them do, he's got to have 66 per cent more pay in order to receive the same amount of money per year; and, if he worked 80 per cent of the time, he has 20 per cent layoff (which is not at all excessive), and he has to have 25 per cent more pay.

The money which buys food and clothes and lodging is not that which comes in by single days, but that which constitutes the annual income. In all adjustments of wages, either by normal process or by demand, this feature comes in automatically, although often unintentionally.

Seasonal work cannot be prevented by one contractor working alone, although certain contractors have been able to go much further than others along this line; but it can be reduced through organizations of builders and contractors working in harmony with labor. There are large possibilities for the establishment of bureaus or other co-operative plans where construction programs can be worked out in advance and activities co-ordinated.

Basis of Calculations for Loading of Delaware River Bridge

The Delaware River bridge from Philadelphia to Camden, N. J., work on which is now under way, will have a center span 1,750 ft., between towers, exceeding by 150 ft. the longest suspension bridge in the world. It will mark an important advance in suspension bridge designs. The two cables supporting it will be 30 in. in diameter, each composed of 16,500 individual wires. The largest cable now in use is 20½ in. in diameter, while the far-famed Brooklyn bridge has cables only 15¾ in. in diameter. The bridge complete will cost $28,000,000 and will be finished in 1926. Some interesting details regarding this bridge were given by Ralph Modjeski, chief engineer, Delaware River Bridge Joint Commission, in an address Nov. 7 at a meeting of the Philadelphia Section of the American Society of Civil Engineers. The address with the discussion is printed in the January issue of Engineers and Engineering, the publication of the Engineers' Club of Philadelphia, from which the notes following are taken. The following loading has been assumed for the Delaware River Bridge:

	Lbs. per ft. of bridge
Two rapid transit lines	4,000
Two surface car lines	3,000
One 57 ft. roadway at 70 lb. per sq. ft.	4,000
Two 10 ft. sidewalks at 50 lbs. per sq. ft.	1,000
Total	12,000

The heaviest steel rail motor cars operated on rapid transit lines weigh fully loaded with seated and standing passengers 2,150 lb. per lin. ft. The longer cars operated by the [illegible] Railways Co. in New York weigh about 1,900 lb. The elevated cars operated in Philadelphia by the P. R. T. weigh, fully equipped, 69,150 lb. Allowing for a seating capacity of 50 and a standing capacity of 100 passengers, a total load per lin. ft. of 1,840 lb. is obtained.

In adopting 2,000 lb. per lin. ft. as the specified congested moving load per rapid transit track, ample provision has been made for high speed traffic.

The surface cars operated by the P. R. T. with a seating capacity of 53 and a standing capacity of 80 passengers weigh 1,230 lb. per lin. ft. The "Hog Island" cars with a seating capacity of 46 and a standing capacity of 68 passengers, weigh 1,350 lb. per lin. ft.

Allowing 1,500 lb. per lin. ft. per surface car track as the congested load, provision has been made for a possible increase in weight of suburban cars.

Both rapid transit trains as well as surface cars cannot be operated without sufficient clear spacing between successive train units. It has been found that working speeds require a clear spacing between cars at least equal to twice the length of train or car. Thus the surface car load, under working conditions, will be nearer 500 lb. per lin. ft. of track.

When local congestions occur on the main bridge a simple operating ruling keeps the cars spaced at an average of their own length. Such a condition would result in 750 lb. per lin. ft. of track.

The average weight of forty-three types of fully loaded motor trucks was found to be 728 lb. per lin. ft. and that of 25 types of passenger cars 312 lb. per lin. ft. Allowing for six lines of vehicles over the bridge, three lines of motor trucks and three lines of passenger cars, a load of 3,120 lb. per lin. ft. of roadway would result. The traffic count made by the commission showed about 40 per cent of the traffic to be motor trucks. In the above figures the higher ratio of 50 per cent was assumed. Observations made at other places by engineers gave 500 lb. per lin. ft. for a line of automobiles and trucks mixed.

For the design a congested load of 4,000 lb. per lin. ft. of bridge has been assumed, an excess of 28 per cent.

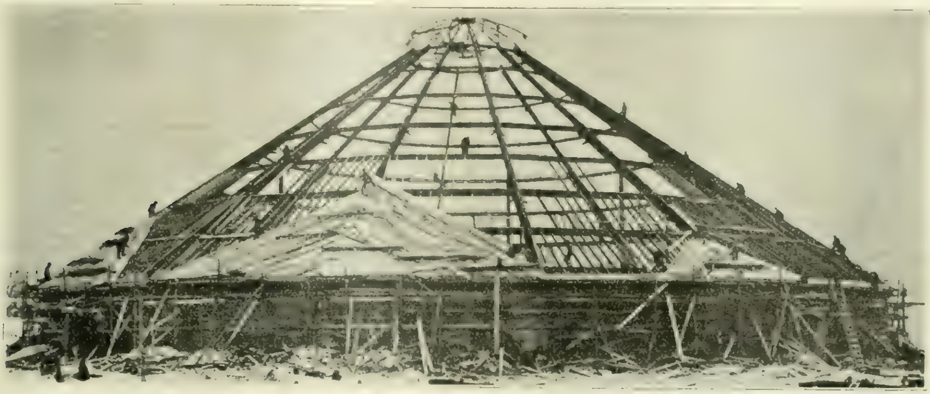
Thus the possible loads that may cross the bridge have been fully taken care of and also an allowance for a future increase in weight of vehicles has been provided.

This 12,000 lb. per ft. of bridge therefore means congested loading; that is, the roadway filled with automobiles and trucks in close contact, the four tracks covered closely with cars filled to capacity with passengers, and the sidewalks carrying one pedestrian for each 3 sq. ft. Under this congested loading and under most unfavorable conditions of wind and temperature the stress in the cables will not exceed 72,500 lb. per sq. in., or half the elastic limit. The stress in the towers will not exceed 27,000 lb. per sq. in., or half the elastic limit and in the stiffening trusses 40,000 lb. per sq. in., or less than three-quarters of the elastic limit. In the Manhattan Bridge it was calculated that under ordinary working load no portion of the stiffening truss is stressed more than one-quarter of the above unit stress or 10,000 lb. per sq. in. The reasons for assuming a higher unit stress for the stiffening truss than for the other portions of the bridge are that should any one of the members fail there will be no serious consequence and that the maximum stress in the stiffening trusses would require a distribution of loading which is improbable; such, for instance, as the congested loading on one side of the side spans and no loading at all on the rest of the bridge.

County Planning Commissions.—In a discussion at the recent American Society of Civil Engineers' Symposium on Housing, Nelson P. Lewis, consulting engineer, New York City, stated that Westchester County, in New York State, has been, as far as he knows, the first county, at least in this part of the United States, to establish a County Planning Commission. Probably the commission has not yet attempted to exercise much authority, but it is a hopeful sign. He added that counties contiguous to great cities do not themselves attempt to control development, it will be necessary, in the public interest, to give the cities themselves some degree of jurisdiction over the planning of territory beyond their corporate limits. This has already been done in many cases, and a recent canvass of 27 typical cities made by Mr. Lewis shows that in 10 of them the City Planning officials have jurisdiction varying from 1 mile to 15 miles beyond the city boundary. In the case of the other 17, which include both New York and Philadelphia, there is no jurisdiction whatever outside the city limits.

Design and Construction Features of Steel Frame Roof of Large Rink

A rink of unusual design and large dimensions has been completed recently at Moncton, N. B., Canada. The building is circular in plan, 200 ft. in diameter, the outside wall being of concrete 17 ft. high. Above this is a roof approximately conical, rising to a height of 90 ft. above the ground. The interior is entirely free of obstructing columns and provides a rink space of 180 ft. by 90 ft., accommodations for over 3,000 spectators, a cafeteria, retiring rooms and a promenade 600 ft. long. The roof consists of a structural steel frame with wooden cover. The design and construction features of this roof are described by E. Holgate, chief engineer, MacKinnon Steel Co., Ltd., the contractors for the design, fabrication and erection of the steel work, in a recent issue of The Contract Record, to which we are indebted for the matter that follows:



Construction View of 200 Ft. Diameter Rink at Moncton, N. B.

Design of Roof.—The structural steel consists primarily of sixteen rafters, each 105 ft. long, shipped in two lengths, lower and upper. The extreme lower ends rest on steel columns. At the eave of the roof a continuous tie plate takes the tension stress and it is made in 16 straight sections each approximately 40 ft. long. The wooden roof joists rest on the wall at one end and on seven rows of steel purlins above. The tops of the rafters stop 15 ft. from the vertical axis of the building, thus providing an opening 30 ft. in diameter on which stands a cupola admitting light and ventilation. The purlins are designed for both the bending and compression incidental to this type of construction. To provide for irregular distribution of live loads a system of radial bracing is attached to the main rafters at a height of 50 ft. and the upper ends of the rafters are connected by 16 radial struts. Lateral stresses are brought down to the tie plate by adjustable rod bracing in the planes of the rafters and the tie plate is well anchored to the wall all the way around the building. The roof is of 1 in. plank, tongued and grooved, covered with roofing felt and nailed to 2 in. by 8 in. joists about 15 ft. long. The planks are laid diagonally, alternating in direction on each of the 16 planes of the roof.

Erection of Steel.—The erection of the roof steel was accomplished in 20 working days of wintry weather. It involved some interesting expedients. First a guy derrick was set up 4 ft. from the central vertical axis. This derrick had a mast 112 ft. high and a boom 106 ft. long and it could lift 6 tons at radius of 101 ft., thus controlling the whole area of the building.

The main tie plate was erected by resting the ends of the sections on the wall, setting them to a pencil line scribed thereon, at a uniform distance from the geometrical axis. The closing section of tie plate therefore slipped straight into place without any time being lost in correcting inaccuracies of radii. The plate was then carefully levelled by wooden wedges.

Next the lower section of the first rafter, 62 ft. long and weighing 4 tons, was hoisted into place and held suspended by the derrick whilst its lower end was attached to the tie plate and a temporary wooden post, 10 in. by 10 in., 40 ft. long, was placed underneath by means of a rope pulled over the niggerhead of the hoisting engine and passing through a block near the end of the derrick boom. A transit over the building axis aligned the rafter in a true radial vertical plane whilst a level was set to a line on the wooden post at a known distance from the point where it touched the bottom flange of the rafter. The latter point was fixed by a lug riveted to the beam at a carefully measured distance from the tie plate. Wooden wedges under the wood post enabled it to be exactly adjusted in height. After guying the end of the first rafter, the second was erected similarly, and the connecting purlins followed.

When the sixteenth rafter was placed it was found that the precaution taken to ensure the easy assembling of the closing sections of the purlins was successful. This was done by setting the wooden posts so that their tops were ¾ in. higher than calculated, thus making the diameter about 1 in. too much and the circumference about 3 in. too much. The closing purlins were held up by long bolts, completing the lower cone of 16 rafters and four rows of purlins. The wedges under the wooden posts were then slackened until each post was lowered ¾ in. to correct geometrical level. By the time the last post was adjusted it was found that the gaps in the four purlins of the closing panel had disappeared and that the weight of the roof had entirely left the temporary wooden posts.

The latter, however, were not removed because they had another duty when erecting the upper rafters. The erection of these proceeded along with the three upper rows of purlins by cantilevering them from the upper ends of the lower rafters. Although the top ends of the upper rafters were 60 ft. from the wooden posts, the weight of the lower tie plates and columns was more than sufficient to counterbalance them. Hence, the lower cone was still supporting itself with its stresses unaffected by the erection of the roof above it. The upper cone was closed by the three purlins of the last panel being powerfully forced into position by derrick and blocks, a procedure which simultaneously corrected the slight deflections contingent upon the cantilevering of the rafters and released all weight from the wooden posts below. To facilitate this operation the upper bracing was not inserted until after closure was made.

Finally the cupola trusses were placed, derrick dismantled, and then the radial rods and top struts were erected by rope blocks. After tightening all lateral bracing and riveting all purlin connections, rafter splices and tie plate splices, the wooden posts were removed.

Building Material Prices.—Mimeographed tables showing the prices of 24 classes of building materials at 44 cities in different parts of the country, as of Feb. 1, 1922, have been compiled by the Division of Building and Housing of the U. S. Bureau of Standards. They may be obtained by addressing the above-mentioned division of the bureau at Washington, D. C.

Effect of Moisture Content on Concrete

Results of a study made in the Engineering Experiment Station of the University of Illinois to determine the effect of the moisture content upon the expansion and contraction of plain and reinforced concrete are given in Bulletin No. 126 issued recently by the station. The experiments were made in 1918 by T. Matsumoto, a graduate student in theoretical and applied mechanics at the university. The notes following are taken from the bulletin.

Purposes of the Tests. The tests were made to investigate the amount of shrinkage which may be expected in a mortar or a concrete, the relation between the change of moisture content and the change of length of these materials, the difference in shrinkage of plain and reinforced concrete, and the internal stresses set up in the latter. For purposes of comparison with the results obtained with concrete, a few tests were made on the effect of the absorption of water by sandstone and limestone.

Materials Used in Test Specimens.—The materials used in making the concrete test pieces were all of good quality. Universal portland cement was used. The fine aggregate was a well graded sand from Attica, Ind. The coarse aggregate was gravel from Attica, Ind. It was all screened to a size between ¼ and ½ in.; larger sizes were not used because of the small dimensions of some of the test pieces. The steel used in the reinforced concrete test pieces consisted of plain round mild steel bars. In none of the tests did the measured stress in the steel approach the elastic limit of the material.

All concrete was hand mixed, and each test piece was made from a separate batch of material.

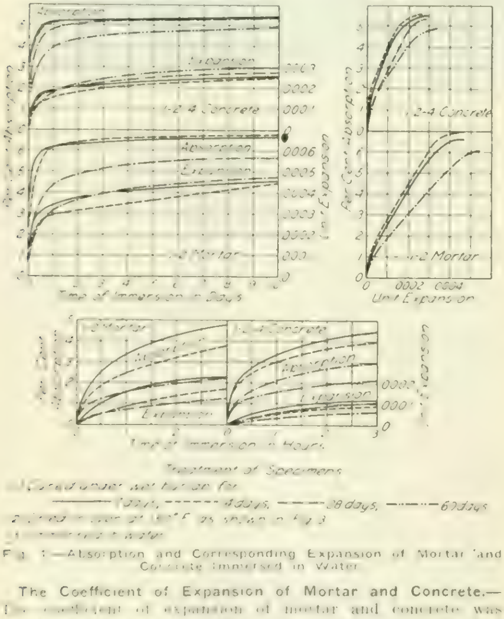


Fig. 1.—Absorption and Corresponding Expansion of Mortar and Concrete Immersed in Water

The Coefficient of Expansion of Mortar and Concrete.—The coefficient of expansion of mortar and concrete was required for use in making a temperature correction of measurements. It was obtained from perfectly dried specimens only, so that there was no error due to the change in length with a change in moisture content of a specimen. The measurement of length was made by the use of a Berry strain gage, and the temperature was measured by a thermometer which was so placed among the test pieces that radiation of heat did not affect the reading.

The results obtained indicate that the coefficient of expansion of mortar and concrete is practically the same for different proportions and ages, provided that the same materials are used in all mixtures. The average values of the coefficient of expansion of 1:1, 1:2, and 1:3 mortar, and 1:1:2, 1:2:4, and 1:3:6 concrete, varied from 0.0000050 to 0.0000058 for 1° F., with no particular variation with the age or with the richness of the mixture.

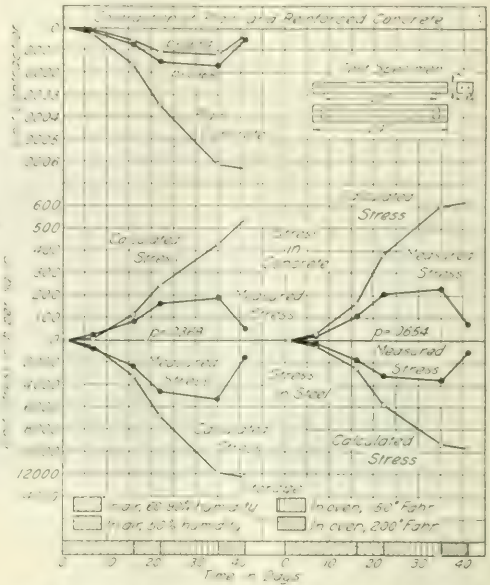


Fig. 2.—Shrinkage Stresses in Reinforced Concrete Specimens

Effect of Moisture Content on Length of Specimen.—Thirty test pieces, 2 by 3 by 24 in. in size, containing 2 steel plugs which formed a 20-in. gage line, were made of 1:1, 1:2, and 1:3 mortar, and 1:1:2, 1:2:4, and 1:3:6 concrete, five test pieces for each mixture. One day after the test pieces were made the molds were taken off, and initial measurements of the length and weight were made. All test pieces were then stored in a damp room and covered with double sheets of burlap which were kept wet. The measurements of length were made with a Berry strain gage of 20-in. gage length, using as a standard a steel bar immersed in water of known temperature. All measurements were corrected for the effect of temperature change. Changes in weight were taken to mean gains or losses in moisture content.

After 60 days of damp storage all test pieces were stored in air in a room where the relative humidity varied from 40 to 60 per cent when the room was heated by steam. As soon as the steam heating was discontinued with the advance of the season the relative humidity of the room increased, and it reached 90 per cent on cloudy days; whereupon the mortar and concrete absorbed moisture from the air and began expanding instead of contracting. After being kept 90 days in the air of this room the specimens were

TABLE I—CHANGE IN MOISTURE CONTENT AND CORRESPONDING CHANGES IN LENGTH

(Expansion and contraction are given in per cent of gage length.)

	[illegible]		[illegible] 78 days		Dried in oven at 110° F 14 days		Dried in oven at 200° F 15 days	
	[illegible] per cent	[illegible] per cent	[illegible] per cent	Contraction per cent	Loss of moisture per cent	Contraction per cent	Loss of moisture per cent	Contraction per cent
[illegible]	[illegible]	[illegible]	[illegible]	0.0160	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	1.57	[illegible]	[illegible]	[illegible]	1.18	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	1.25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	1.91	[illegible]	[illegible]	[illegible]	3.17	[illegible]

dried for 14 days in an oven at a temperature of 150° F., and then for 15 days at 200° F. The amounts of change of moisture and length during the test are shown in Table I. A 1:1 mortar at 70 days contracted 0.025 per cent, notwithstanding the fact that it contained more moisture than its initial amount. From this phenomenon it can be concluded that the water which goes into the concrete may exist in two different ways, either combined with cement in a chemical compound or remaining in a state which affects the volume of the concrete. It also appears that concrete in which the total moisture content is kept constant for some length of time is liable to contract slightly. This slight contraction was observed on several occasions during the test. It follows that the absolute amount of contraction of concrete due to drying is indeterminate, because it depends upon the age of the concrete and the duration of the drying period. In general these specimens of mortar and concrete expanded when they were kept wet. The richer mixtures absorb more water and consequently expand more than the leaner ones. Mortar and concrete lose moisture rapidly when placed in dry air and the loss is more rapid in lean mixtures than in rich ones. In air storage the shrinkage is greater for mortar than for concrete, and with artificial drying the shrinkage is greater for the richer mixtures.

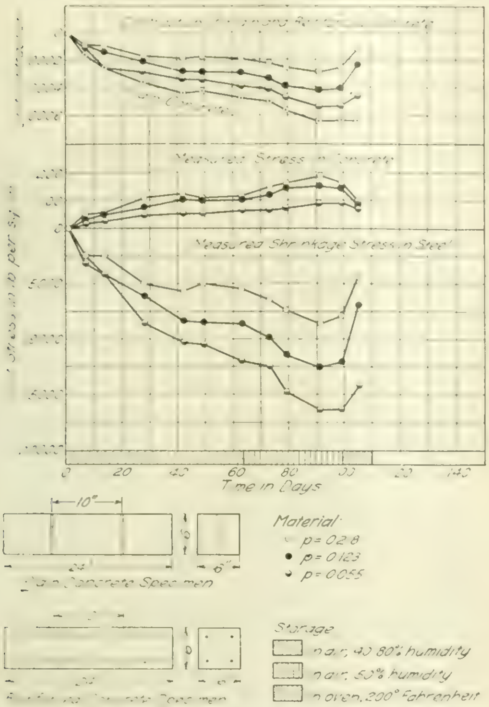


Fig. 3.—Shrinkage Stresses in Reinforced Concrete Specimens.

For the specimens tested, the contraction of mortar and concrete at a temperature of 150° F., which is somewhat higher than the highest outdoor temperature in summer in a tropical climate, was 0.12 per cent for 1:1 mortar, 0.10 per cent for 1:2 mortar, 0.09 per cent for 1:3 mortar, 0.07 per cent for 1:1:2 concrete, 0.06 per cent for 1:2:4 concrete, and 0.06 per cent for 1:3:6 concrete. The amount of expansion when specimens were kept wet reached 0.012 per cent in 1:1 mortar, and 0.002 per cent in 1:3:6 concrete, at the end of 60 days. Judging from these tests, shrinkage of concrete in a structure freely exposed to the air may be as much as 0.05 per cent in a 1:2:4 concrete. In a structure such as a retaining wall or a road pavement, where one side of the structure is against a mass of earth, the shrinkage should be considerably less.

In a second set of tests 24 test pieces, having the same size and form as those in the tests previously described, were prepared from the same materials, half of mortar with the proportions of 1:2, and half of concrete with the proportions of 1:2:4. The test pieces were stored in a damp room and covered with burlap which was kept wet. Three specimens of each kind were taken out of the storeroom when they had hardened 7, 14, 28, and 60 days, respectively, in the damp condition, and were then dried in an oven at a temperature of 150° F. until the loss of weight did not exceed 0.20 per cent during 24 hours. The test pieces were then immersed in clean water in a shallow tank. The lengths of the specimens were measured by a 20-in. Berry strain gage and all measurements were corrected for the effect of temperature changes in the instrument.

It was shown that the rate of loss of moisture in mortar and concrete by drying decreases with the age of the specimen. In the mortar, the rate of loss in specimens 28 days and 60 days old, respectively, becomes nearly the same. The total loss in moisture in mortar does not seem to be greatly different from that in concrete at the four ages used.

A number of significant features of the second set of tests are brought out in Fig. 1:

(a) Dry mortar and concrete expand as soon as they absorb water.

(b) The rate of absorption upon immersion is much less for the older specimens during the first two or three days of immersion, although the total amount of absorption does not change very greatly for specimens of different ages.

(c) The rate of expansion due to immersion is also less for the older specimens during the first two or three days of immersion. For longer periods of time the amount of expansion is nearly the same for all ages of each material; but in every case the expansion is considerably greater for mortar than it is for concrete.

(d) The amount of the expansion of mortar and concrete is small until an absorption of nearly 2 per cent is reached. After this point the expansion becomes nearly proportional to the additional absorption of moisture. This holds true until a sudden decrease in the absorption occurs after about one day's immersion, beyond which point additional absorption gives a greatly increased expansion.

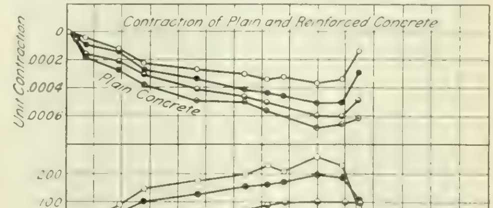


Fig. 4.—Shrinkage Stresses in Reinforced Concrete Specimens.

(e) The absorption of moisture by mortar or concrete be much more rapid than the drying out of moisture from the same material. As a result the expansion due to wetting is more rapid than the contraction produced by drying. For example, a mortar 7 days old gained as much moisture in 2 hours' immersion as could be dried out by heating to 150° F. for 24 hours.

Another experiment on the relation between absorption of moisture and expansion of concrete was made upon two specimens of 1:2:4 gravel concrete taken from a floor of the Western Newspaper Union Building in Chicago. The concrete was 9 years old. The sizes of the test pieces were 3.5 by 5 by 24 in. and 3.5 by 5 by 26 in. The specimens were dried for 13 days in an oven at a temperature of 150° F. In drying, the average contraction of the concrete was 0.016 per cent for the two specimens. After immersion in water for 15 days the average absorption was 5.09 per cent and the resulting expansion 0.042 per cent.

Absorption by Sandstone and Limestone. For comparison with the behavior of mortar and concrete, a few tests were made on the absorption of water by stone. The specimens used were sandstone and limestone which had nearly the same porosity as the mortar and concrete tested. If the expansion of such material is due to the separation of particles, the same amount of expansion might be expected with stones of the same porosity.

Two specimens of a reddish brown sandstone of good quality, obtained from the Lake Superior region for use in the construction of a university building, were used in the test. The sizes of the specimens were 3 by 4 by 24 in. and 3.5 by 4 by 25 in. Both pieces were dried for 6 days in an oven at a temperature of 150° F. After immersion in water for 13 days, the average absorption for the two specimens was 5.75 per cent, and the corresponding expansion was 0.050 per cent.

The limestone specimens used in the test were a good quality of oolitic limestone of the kind used for building purposes, commonly known as Bedford Indiana stone. The stone has a porous structure. The two test pieces were 3.5 by 4.7 by 11.1 in., and 3.5 by 4.75 by 12.5 in. in size. The first speciment was dried for 7 days in an oven at 150° F., with consequent loss of moisture, due to the drying, of 1.04 per cent, and no measurable contraction. The second specimen was dried for 11 days in an oven at 150° F., with consequent loss of moisture of 1.42 per cent and no measurable contraction. They were then immersed in water. After an immersion of 6 days the average absorption was 6.1 per cent with practically no expansion.

The very rapid absorption and the lack of expansion of the limestone are in decided contrast to what occurred with all the other materials used. The behavior of the limestone throws doubt upon the theory that moisture entering a porous substance causes an expansion of material through separation of the particles.

Shrinkage Stresses in Reinforced Concrete.—Two sets of tests were made for the purpose of measuring the shrinkage stresses in reinforced concrete specimens. For the first set of experiments six test pieces, 2 by 3 by 24 in. in size, were prepared, two of them being of plain concrete, two having two ⅜-in. round steel bars (p = 3.68 per cent), and two having two ½-in. round steel bars (p = 6.54 per cent). The proportions of the concrete were 1:2:4. The specimens were dried in the air of a room for 22 days, then they were dried in an oven for 13 days at a temperature of 150° F.; and finally they were dried for 6 days at a temperature of 200° F.

The change of length was measured on a 20-in. gage line between points on each embedded steel bar in the reinforced concrete test pieces, and between points on steel plugs embedded in the plain concrete test pieces. The results, which were very uniform in companion specimens, are shown in Fig. 2.

As may be seen from Fig. 2 even reinforced concrete having a very high percentage of reinforcement contracts rapidly in air. When the specimens were 22 days old the shrinkage stress in the concrete reached 166 lb. per square inch in the specimens having 3.68 per cent reinforcement, and 283 lb. per square inch in the specimens having 6.54 per cent reinforcement.

The same specimens, after being dried 13 days longer at a temperature of 150° F., developed stresses of 190 lb. per square inch and 240 lb. per square inch, respectively, which nearly correspond to the ultimate tensile strength of the concrete. Following this being dried at a temperature of 200° F., the concrete failed in tension and showed two transverse cracks at points about 8 in. from each end.

This last case, however, may not be representative, because there may have been some injury to the texture of the concrete when it was heated beyond 200° F. But the fact that the shrinkage stress in the concrete reached 170 to 200 lb. per square inch in 22 days, in the air of a room, may be sufficient reason for concluding that cracks will eventually be formed in concrete which has a high percentage of reinforcement.

The sudden drop of the shrinkage stress in the concrete when heated beyond 200° F., as shown in Fig. 2, indicates injury to the concrete at this temperature; so that the use of reinforced concrete exposed to a temperature higher than 200° F. may be dangerous unless proper precautions are taken.

A second set of tests was made in which smaller percentages of reinforcement were used. The size of the test pieces was 6 by 6 by 24 in. and they were made of 1:2:4 concrete. Deformations were measured on a gage length of 10 in. One piece was made without reinforcement, one with four ¼-in., one with four ⅜-in., and one with four ½-in. round steel bars. A similar set of test pieces was made with the same amount of reinforcement, but which had in addition three anchor-lugs welded to each end of the reinforcing bars to guard against a slipping of the reinforcement during the setting of the concrete; a test piece of plain concrete was also included in this set. The size and form of the test pieces are shown in Figs. 3 and 4.

These specimens were left in the air of the room for 99 days. They were then dried in an oven at a temperature of 200° F.

In the case of the plain concrete, the results of the two sets of tests were quite uniform, both as regards the loss of moisture and the resulting contraction during setting and hardening. The difference between the contraction of plain concrete specimens and those having different amounts of reinforcement was quite regular at all conditions of storage, and is very instructive. The deformation in the reinforcing bars provided with lugs was greater than the deformation in the plain bar. This indicates that slipping of the bars took place with the latter during the shrinking of the concrete; the shrinkage stress is seen to be greater in reinforced concrete having good anchorage of the reinforcement. In general some slipping must be expected.

The measured stress in the steel reached 18,000 lb. per square inch in the specimen having reinforcement of 0.55 per cent, and the stress in the concrete reached 250 lb. per square inch in the specimen having reinforcement of 2.18 per cent. This stress in the steel exceeds the accepted working stress of soft steel and the stress in the concrete is nearly equal to the ultimate tensile strength of concrete of this kind.

When these specimens were heated above 200° F. these stresses both in concrete and steel suddenly dropped down, probably due to injury of the concrete by the heat.

Lumbermen's Convention at Chicago.—The 20th annual meeting of the National Lumber Manufacturers' Association will be held April 4 and 5 at the Congress Hotel, Chicago, followed April 6 and 7 by an American Lumber Congress. The matter for consideration by the congress will be trade problems of the lumber industry, of general interest to lumbermen. There will be four business sessions on April 6 and 7 following the opening dinner on April 5. These four sessions will be devoted to the following subjects: First Session. Commercial standards and practices (including claims, arbitration of commercial disputes, terms of sale, etc.). Second Session. Lumber publicity and trade extension (including local advertising, legislation and governmental action, building ordinances, financing of home building, etc.). Third Session. Standardization, inspection. Fourth Session. Report and action on recommendations and resolutions, (including report on permanent organization of the American Lumber Congress).

One Hundred and Forty-three Cities Interested in Zoning.—In an address Jan. 4 at the American Society of Civil Engineers' Symposium on Housing John M. Gries, chief, Division of Building and Housing, U. S. Department of Commerce, stated that more than 50 cities in this country had passed zoning ordinances and 93 cities had zoning ordinances in preparation.

The Engineer as a Citizen

By HARRY TUCKER,
Professor of Highway Engineering, North Carolina State College of Agriculture and Engineering

The editorial in the Feb. 22 issue of Engineering and Contracting, "How Local Engineering Societies and Chapters Can Serve the Public," suggests to my mind the title of this article. If a man's duty to society is measured by his education and training, then there is a large number of engineers who are not doing their duty as citizens. What is a good citizen? To me a good citizen is one who is reasonably law abiding and who uses his peculiar qualifications and talents for the good of the community and state in which he lives. This means that the engineer must interest himself in state and civic problems, and bring to the solution of such problems the peculiarly analytical and business qualifications he possesses. Broadly speaking, the engineers are not doing this; they are not taking the deep interest they should in the political problems of their communities.

Your editorial suggests two reasons why the engineer does not interest himself particularly in local social, economic and political problems. The reasons given are the engineer's lack of time and money. But there is another important reason: The average engineer is a rather migratory individual, and is not for a long period a citizen in any one city or state. Many of them change positions every year or even oftener; many others whose positions are more or less permanent, have their locations changed. In this the engineering profession is quite different from some of the others, notably law and medicine. In these latter professions the members very rarely change their locations. They become fixtures in city or state—become integral parts of the community and, consequently, take a deep interest in all local economic problems.

It has been my observation that, where an engineer's home is permanent, he does take a live interest in politics and local economic problems. I have in mind several engineers who are quite as shrewd politicians as any lawyers, and who are making their political influence felt. On the other hand, I know a great many more engineers who have recently changed their positions and residences, and who are not at all interested in the political problems pertaining to their particular locations. It is a question of becoming acclimated and often before the engineer becomes acclimated he moves to a new location.

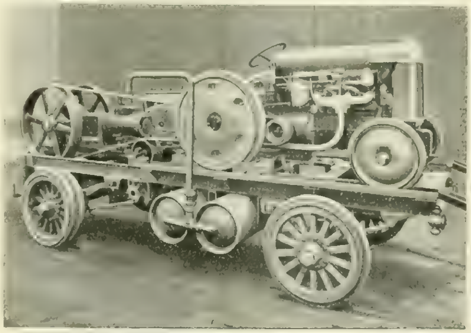
It is not thought that much can be done to interest the migratory engineer in local economic problems. Perhaps the solution is in the direction of making the engineer's own economic position more secure. It is the writer's belief that, in this respect, conditions now are much better than they have been, due partly to the development of highway and municipal engineering. Formerly, large numbers of graduate engineers entered railroad service, with the consequence that their locations were continually changing. Now, many young engineers are entering highway and municipal work, becoming in turn county and maintenance engineers, and city engineers. The foregoing remarks are particularly applicable to the engineers in states where there are a great number of small towns or cities, and where quite a large part of the population is rural. In more densely populated localities, great numbers of young engineers are still entering industrial plans and bridge companies. These, a large majority of them at least, will in turn swell the ranks of the migratory engineers.

The engineer whose business connections are fairly secure will find many opportunities for interesting himself in public affairs. Every small city has a traffic problem. The engineer's peculiar qualifications will enable him to render valuable aid to his community in solving such problems. He might even go further and interest himself in having his state adopt uniform traffic regulations. The state engineering societies could have committees appointed for this purpose—especially a legislative committee to bring before each legislature the need of such a law.

There are many other public matters in which engineers might take an active interest. Every small town has more or less of a "water situation"; there is always the question of street improvement and which particular type of pavement is to be selected; city planning commissions for beautifying the cities; railroad and terminal facilities to be developed; recurrent bond issues for improvements. These are just a few of the many political questions that are continually attracting the interest of the wide-awake citizen. No one is better qualified than the engineer to discuss intelligently these various questions. The engineer should let his voice be heard. Not only will his community benefit thereby, but the engineer himself will be broadened through contact with public thought. The advertising alone he receives will many times pay him for the time given voluntarily to his community. In this connection let me state the case of a young lawyer who moved to a city some years ago. After one year's residence he ran for police justice. On being asked what he expected to get out of his race he replied "Advertising." He was not elected police justice but he did make himself well known to the citizens of that city and his practice today is one of the largest in the city. Would not the engineer do well to follow the example of the lawyers and take a livelier interest in politics; not only for the material gain to be derived thereby, but in order to fulfill his function as a citizen?

Compressor, Truck Body and Tractor Solve Portable Drilling Problem

In wrecking concrete foundations and buildings, and in cutting heavy concrete for doors, passage ways, etc., under conditions forbidding the use of explosives, the time required in getting the necessary equipment to and from the job makes up a considerable portion of the cost. The Graner Contracting Co., 2317 Tennessee St., St. Louis, Mo., specializing in work of this kind, has solved this problem in an interesting manner.


Air Compressor and Tractor on Truck Body.

Small portable compressors mounted on hand drawn trucks answered the purpose at first. These were hauled to the work in wagons or on motor trucks and one of these units furnished air enough for a small hand rotated drill. The reduction in cost over drilling by hand with these outfits formed a nice saving. Increased demand for their services necessitated either larger crews or more of them, or else the use of heavier, faster drilling tools, requiring more air, and higher pressure. Experience of recent years has shown the automatic rotating drill to be three or four times as rapid as the older types in which the steel bit was rotated by hand.

The next question was how to mobilize sufficient air power with suitable rapidity. Horse drawn trucks were too slow and motor trucks too costly.

The attention of the contractor was brought to the Sullivan WK-34 compressor, mounted on a steel truck and adapted for haulage and operation by a Fordson or similar tractor. The length of this combined outfit, and the desirability of employing rubber tires on the granite paved city streets caused the Graner Company to look for an adaptation of the tractor drive idea in a different form. They found it at low cost by picking up a used truck body with running gear in good order, rubber tires, and radiator. This was long enough and strong enough to carry both compressor and tractor. A Sullivan 8 by 8 WG-6 standard compressor, arranged for short belt drive, was mounted on one end of the truck, and the other end arranged to accommodate a Fordson tractor. This was equipped with rubber tires. Angle

Two skids were provided leading from the truck body to the ground. When ready to start on a job the tractor is coupled to the truck chassis and the outfit is hauled by it to the point where the work is to be done. The skids are then placed in position, the tractor mount on the truck body, the operating belt is connected to the compressor, and the required air supply is immediately forthcoming.

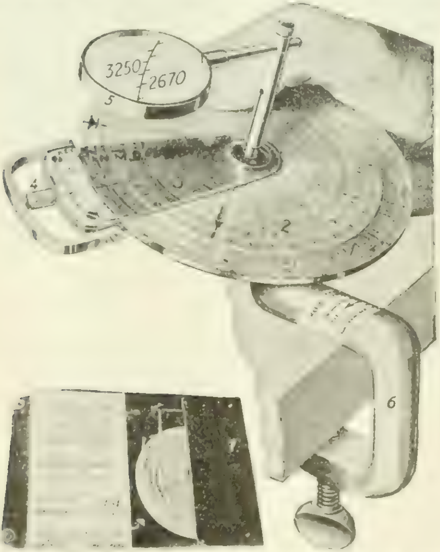
The compressor has a capacity of [illegible] cu. ft. per minute at [illegible] revolutions, and nearly loads the tractor with a terminal pressure of 90 lb. This supplies sufficient air at proper pressure to run a Sullivan rotator at full drilling speed. The standard pulley size of the compressor fits in with the standard pulleys on the Fordson to give proper compressor speed. The illustration shows the complete rig which forms a compact unit of high air capacity, fully rubber tired, to eliminate the jars of the road. The tractor governor handles the work perfectly with the compressor loading and unloading with the demand for air. This also permits a wide range of speed from half to full speed making it possible to run the outfit at the most economical speed for the work in hand. The average gasoline consumption per 8-hour day is 10 to 12 gal., and about ½ gal. of oil is consumed daily. The problem of circulating water for the compressor jacket was solved by connecting the jacket piping to the old radiator which was in good condition, although if desired, an open hopper jacket could have been furnished with the compressor, permitting water to be poured in from a bucket.

The New Ross Rapid Computer

A new rapid computer has been placed on the market by the Computer Mfg. Co., 340 Sansome St., San Francisco, Calif. The computer is one of a series invented by Louis Ross, C. E. It provides an all-metal, circular computer, on the polyphase-duplex principle, but with simplified, longer, and more complete scales. It is convertible for desk or pocket use. The computer consists of two scaled dials, set flush with each other and rotating concentrically. The dials are read by a hair-line engraved under the transparent arm, which is controlled by a thumb-lock. The scales are graduated direct on heavy metal, fine as a transit, but easy to read. A locked conical center forms a precise bearing. The computer is 5 in. in diameter, so that its contact scales are 12½ in. long, like the upper scales of a 25-in. slide-rule. A magnifier, adjustable in focus, radius and direction, facilitates precise interpolations, and makes readings appear larger than ordinary typewriting. To increase accuracy and reduce strain on hand and eye, a desk-clamp is provided, serving like a tripod for a compass; it permits figuring with one hand while writing with the other. The pocket-case for computer and magnifier, serves also as a loose-leaf book, with 3¾ by 6¾ Lefax fillers and folds to 5 by 7 for carrying in pocket. The scales are numbered plainly, 1150, 1160, 1170, etc., so that anyone can read them at first sight, without error. Eleven scales are provided, covering the rapid solution to numeric, trigonometric, and exponential problems, including the measurement and conversion of angles in degrees, mils, or radians. When any problem is set under the computer-arm, a long arrow shows the answer, another arrow proves it. If problem involves three items; any two items are set under arm, opposite third item is the answer. Thus with one setting it solves expressions like:

$$37.98 \times 0.2479 \times 0.763, \text{ or } \sqrt{\frac{0.798}{3.649}}, \text{ or } 2.693 \times 0.487 \tan 28° 12', \text{ or } 0.3597 \times \frac{\sin 72° 43'}{\sin 49° 28'}, \text{ or } \log \frac{0.497}{54.3 \times 0.02487}, \text{ etc., etc.}$$

The key for the principal settings is given graphically on the arm, in plain sight of user. As the computer is circular the answer never runs off the scale. In handling constants, the constant is locked, and cannot shift accidentally, however long the operation, a feature especially valuable in figuring payroll, unit-cost, monthly estimates, where the answer must be infallible. Trigonometric work is solved as simply as plain numbers, without requiring to turn instrument upside down or end for end, or figuring mentally complements or reciprocals of functions. This makes the computer actually practical for figuring triangles, traverses, slopes, and other problems that occur daily in the engineer's and contractor's work.



Computer With Magnifier, Desk Clamp and Loose Leaf Case

Canadian Technical Men in Politics

In a letter to the editor in a recent issue of The Contract Record, Toronto, Canada, A. Langlois calls attention to the small number of technical men taking part in the Government of Canada. He goes on to say:

"This fact is to be regretted, for, not until our engineers organize themselves and come forward in greater numbers may they expect the share due them in the distribution of the control of the country's administration, as well as their share of influence.

"The movement toward a greater participation of scientific men in practical politics is making more progress in the United States where the members of the engineers' associations are urged to interest themselves in the different political parties.

"To illustrate the little interest taken in politics by our Canadian technical men, the following gives the number of engineers or land surveyors who are members of the legislatures of the nine provinces; British Columbia, 2 engineers; Alberta, 1 land surveyor (member of the cabinet); Saskatchewan, none; Manitoba, none; Ontario, 1 engineer; Quebec, 1 land surveyor; New Brunswick, none; Nova Scotia, none, Prince Edward Island, none.

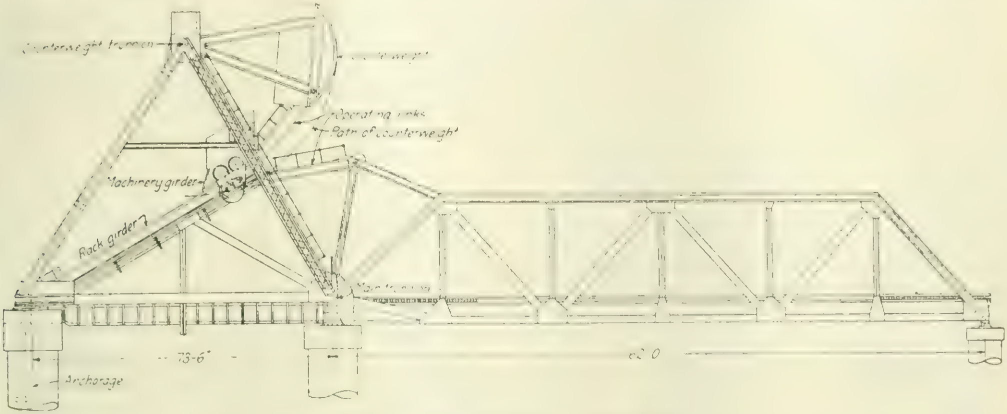
"It is evident that there is a lack of ambition among engineers. There should be ample room in the federal and provincial governments for a good number of them, even cabinet ministers, for the direction of such departments as those of public works, railways, mines, colonization, highways, lands and forests would be in safe competent hands if their administration were entrusted to engineers.

"The engineering profession has too long been considered of little importance, and if there is any truth in the statement coming from some quarters that the university graduate has not the ability to handle men, the means to overcome this situation would seem quite simple. It rests in the development of the students' capabilities by broadening the university courses and especially by the organization of engineers' associations of graduates only, and which would finally merge into one central organization. A good start in that direction has already been made in most provinces of the Dominion, and it is to be hoped that the organizers of the movement for an association of engineers in Ontario will be early at work for the next session of the legislature and will see that the bill providing for it is successfully carried through this year."

New Development in Bascule Bridge Design

A new design of bascule bridge was placed in service on Jan. 26 at the Wabash R. R. crossing of the River Rouge at Detroit, Mich. The bridge comprises a single leaf span of 162 ft., a tower span of 73 ft. 6 in. and a deck girder approach span of 53 ft. 2 in. It replaces a double-track swing span which would not fulfill the requirements of a statute passed by Congress in 1917 providing for the improvement of the River Rouge to afford a waterway 200 ft. wide with 125 ft. clear openings at bridges. The design, which is now known as the "Abt type," was made by the American Bridge Co. and the contract for the superstructure was awarded to that company. We are indebted to the Railway Age for the following particulars regarding this bridge:

In this type of bascule bridge the counterweight is suspended from a trunnion located at the apex of a triangular-shaped counterweight tower. The linkage mechanism by which this counterweight is connected to the bridge span is a novel part of the design, giving to the contra-rotating counterweight the same angular velocity as the span. Expressed in other words, this means that the angle between the horizontal (or vertical) and the line connecting the pivot with the center of gravity of the counterweight is always identical with the angle between the horizontal and a line connecting the main trunnion with the center of gravity of the leaf. One of the links acts as a strut supporting the counterweight while its fellow is a tension member connecting it to the movable leaf.



General Elevation of the River Rouge Bridge.

The counterweight consists of a basket of structural steel filled with concrete and suspended from the counterweight trunnion by stiff hangers. This basket is enclosed on all sides, except on the side toward the pivot. This form of construction has the advantage, therefore, that it may be erected in the hanging position by a locomotive crane without the use of any falsework. Also the necessary concrete may be poured inside the structural steel basket without the aid of any forms.

The bridge is operated by machinery mounted on a cross girder of structural steel which travels up and down two inclined members equipped with racks. This cross girder is joined to the compression and tension links at their common pivot.

The main power equipment of this bridge comprises two 100-H.P. electric motors operating on three-phase, 60-cycle, 440-volt alternating current. Either of these motors is capable of operating the bridge alone and is connected to the operating shaft by separate clutches, the object being to use these motors alternately, thereby giving greater assurance that one motor will always be in working order. To allow for failure of electrical power, a 58-H.P. gasoline engine is provided as an auxiliary unit. The power equipment has been geared so that either of the motors will open or close the bridge in less than $1\frac{1}{2}$ minutes and the gas engine in about eight minutes.

Each electric motor has a solenoid brake for full torque, one of these brakes having an attachment to transform it to a hand brake if the gasoline engine is to be used. On the motor shaft an air brake has been installed for full torque of the two motors; also two emergency brakes entirely independent of the machinery, arranged to grip I-beams attached to the inclined girder. These brakes can develop 175,000 lb. holding power and are supplied with air from a line entirely independent of the brakes to the motor shaft. All the brakes have been designed to set slowly and to release quickly.

The air for the brakes is supplied by a compressor rated at 25 cu. ft. of free air per minute, with a governor to insure uniform pressure. The bridge is operated by remote control from an operating house located south of the bridge, which also contains the interlocking machine.

The masonry supporting the A-frame and main trunnion consists of four cylinders 12 ft. in diameter sunk to rock by the pneumatic process and connected crosswise of the bridge by a pier and abutment resting on the cylinders. The rest pier is of concrete extending below the bed of the river and supported on piles driven to rock.

The bridge was fabricated at the Gary plant of the American Bridge Co. with Albert Reichmann, western division engineer, in charge. The erection was under the direction of James L. deVou, Pittsburgh division erecting manager of the American Bridge Co.

New Working Rules for Bricklayers, Masons and Plasterers. - New working rules for approximately 119,000 members of the Bricklayers, Masons & Plasterers' International Union of America are established by a consent decree drawn up and signed in Washington on Feb. 24. The decree followed a conference with Attorney General Daugherty with the leaders of the union. It will be entered in the United States Court in New York. The work of preparing a decree that would be accepted by more than 50 representatives of the various locals throughout the United States and by the government followed research and inquiry on the part of the federal officials for nearly four months. The decree provides in brief:

There is to be no limit to the productive capacity of the individual workman within the working day or any other time.

There is to be no limit upon the right of the employers to purchase their material wherever and whenever and from whomever they may choose, whether these materials be union made or otherwise.

There is to be no favoritism shown by organized labor toward employer or trade associations and no discriminations are to be indulged in against the independent employer who may not be a member of such an organization.

The labor organization is not to be used, or permit itself to be used, by material men or contractors or subcontractors as an instrument for the collection of debts or enforcement of alleged claims

The New Chicago Passenger Station of the Illinois Central R. R.

Clearly defined as one of the important steps in the electrification and improvement of the Illinois Central R. R. as provided for in an ordinance passed by the Council of the City of Chicago July 21, 1919, appears the construction of the new central passenger station.

In location the station will have many marked advantages, because of easy accessibility to the downtown business district as well as to the Field Museum of Natural History, the new stadium, and to Grant Park with its system of driveways and lagoons which will extend for many miles along the right of way of the railroad company. The new passenger terminal will be easily reached from all parts of the city by means of the elevated railroad, the street car lines and taxicab service and particularly from the north and south by means of the electrified Illinois Central suburban service, which will be 45 miles in length and from which direct connection will be made with the new station by means of commodious ramps and elevators.

The new station building will be located east of Michigan Avenue and just south of East Roosevelt Road. This latter street is to be made an east and west boulevard 118 ft. in width and will be extended entirely across the right of way of the railroad as a viaduct to connect with Grant Park. The upper level of the viaduct will connect directly with the waiting room of the new station. The plans for the new passenger station contemplate the erection of one of the finest passenger terminals of the world and one which will be of ample size to accommodate a number of railroads other than those now using the present Central Station. In style of architecture it will probably harmonize with the classic design of the Field Museum. Provision will be made for 25 station tracks on the upper level and for the possible addition of approximately an equal number on a lower level at some future date.

An important accessory to the proposed passenger station will be the construction of a tunnel, located just north of and parallel to East Roosevelt Road, extending east and west under the railroad company's right of way. This tunnel will accommodate surface line cars and will be connected with the passenger station for the convenience of passengers arriving by this means.

With the construction of the new station many changes and improvements will be inaugurated for the benefit of the traveling public. It is proposed to erect a modern hotel building adjacent to and directly connected with the station in much the same manner as was done at Grand Central and Pennsylvania Terminals in New York City.

The coach yards and mechanical facilities will be suitably located south of the passenger station and will include all necessary appurtenances for the storage, repair and cleaning of equipment used by the railroads which will enter the station. Adequate facilities will also be provided for the handling of baggage, mail and express and will be located convenient to the station.

The suburban tracks will be carried under the passenger station through a tunnel located on the west side of the right of way and will be depressed to an elevation approximately ten feet below lake level.

Another important development in this program will be the construction of a new suburban passenger station at Randolph street, commodious in size and modern in all respects, which will be directly connected with the present pedestrian subway under Michigan avenue at Randolph street and thus remove the hazard to suburban patrons crossing Michigan avenue at street grade. Similar improvements designed to add to the safety of the traveling public are proposed for a number of other points, including a pedestrian subway under Michigan avenue at and directly connected to the new passenger station.

In order to make possible all these terminal improvements, it will be necessary to completely reconstruct all of the present tracks and facilities, both freight and passenger, from Lake street south, a distance of six miles. The program will involve the expenditure of millions of dollars in addition to the cost of the new passenger station and of electrification.

D. J. Brumley, Chicago, is chief engineer of the Chicago Terminal Improvement of the Illinois Central R. R.

Personals

Edmund H. Gibson has been appointed assistant to the building inspector of Richmond, Va., and will serve as technical expert.

Clyde C. Kennedy, consulting engineer, San Francisco, Calif., has changed his office from the Holbrook Bldg. to Room 626 Call Bldg., New Montgomery and Jessie Sts., San Francisco.

Prof. C. C. Williams, head of the Department of Civil Engineering at the University of Kansas, has been appointed head of the Department of Civil Engineering at the University of Illinois.

T. R. Fluker, for the past several years superintendent of the Griffin Gas, Light and Water Works, has accepted the position of manager of the commission form of government of Quitman, Ga., and will assume his duties about April 1.

William McClellan, Peter Junkersfeld and Horace T. Campion announce the organization of the firm of McClellan & Junkersfeld Incorporated, for the general practice of engineering and construction, with offices at 15 William St., New York.

Col. George L. Watson has removed his office from 16 West 31st St. to 150 Nassau St., New York City, at which latter address he will continue his consulting engineering practice. In his new offices, associated with those of the George A. Johnson Company, consulting engineers, Col. Watson, in addition to serving his personal clientele, will collaborate on the engineering work of the Johnson Company.

The Watson Engineering Co., architects and engineers, 664 Prospect Ave., Cleveland, O., announces that H. E. Hadlow and W. P. Brown have retired from the company as vice president and secretary respectively, and have been succeeded by Chas. D. Watson as vice president and Mr. R. L. Harding as secretary. Wilbur J. Watson continues as president and has resumed active management of all of the company's affairs. S. F. Aylow resumes the position of treasurer, succeeding the late A. E. Warner. Chas. D. Watson has had an experience of over 20 years in the design and construction of various classes of buildings. R. L. Harding has been with the company as estimator and purchasing agent since his return from France in 1919.

Obituaries

George Schlender, a civil engineer of the Westinghouse Electric Co., died March 8 at his home, 100 Scott Ave., Los Angeles, Calif., aged 43.

Alexander M. Gow, assistant chief engineer of the Oliver Iron Mining Co., died March 8 at his home, 1913 East 4th St., Duluth, Minn., aged 66. He was a graduate of Ohio State University. He served several years as engineer for the Panhandle Railroad with headquarters at Columbus, Ohio, and later with the engineering department for the Fuel Gas Engineering Company. He came to Duluth in 1895.

William H. Garland died March 7 at New Orleans, La. Mr. Garland was born in New Orleans in 1845, but the greater part of his life was spent in other parts of the country and abroad. He served during the Civil War under Stonewall Jackson. Following his army career he was for 18 years with the Edgar Thompson Steel Works, near Pittsburgh, and later was engaged in railway construction work in Europe, China, Central and South America.

William John Jackson, division engineer of the Minnesota Division of the Chicago & North-Western Ry. Co., Winona, Minn., died March 15, 1922, having suffered an attack of pneumonia a week prior to his death. Mr. Jackson was born Jan. 1, 1875, in Chicago, Ill., was educated in the Chicago Public Schools and the University of Illinois. He began his engineering work with the Chicago & North-Western Ry., starting as tapeman April 1, 1899, served as rodman, instrumentman and assistant engineer until he was appointed acting division engineer, Minnesota and Dakota Division, May 15, 1909; acting division engineer Ashland Division on April 1, 1912; appointed division engineer Madison Division, Jan. 11, 1913; promoted to Division Engineer Minnesota and Dakota Division, May 12, 1913, where he served until his death.

Industrial Notes

L. P. Lessard, formerly assistant sales manager for The T. L. Smith Co., Milwaukee, Wis., has been appointed district manager for the Chicago territory for The H. W. Roos Co., concrete form specialists, of Cincinnati.

George S. Hedge, formerly treasurer Harold L. Bond Co., and Frederick W. Matthews, formerly vice president Wade Bros. & Bond Co., have organized the Hedge & Matthews Co. with offices at 36 Dorchester Ave., Boston, Mass., and will deal in construction equipment.

W. B. Louer Co., construction equipment, 11 E. Harrison St., Chicago, is now handling the Foote paving mixer and the Cropp building mixer, the Le Roi 2 and 3 cylinder gasoline engines, the Beach Manufacturing Co. of Charlotte, Mich., road machinery and the Shawnee tractor made by the Shaw-Enochs Tractor Co. of Minneapolis. These new lines being added since the road show.

The plant and interests of the Pelton Water Wheel Co. of San Francisco and New York have been purchased by the William Cramp & Sons Ship & Engine Building Co. of Philadelphia. The Pelton Water Wheel Co. will retain its corporate name and no material changes of policy are contemplated, but new officers have been chosen as follows: H. B. Taylor (vice president of The William Cramp & Sons Ship & Engine Building Company), president; Ely C. Hutchinson (formerly chief engineer of The Pelton Water Wheel Co.), vice president and general manager; William M. [illegible], second vice president.

Trade Publications

The following trade publications of interest to engineers and contractors have been issued recently:

Hoists.—The [illegible] Hoist Co., 307 McDonough St., Brooklyn, N. Y. Folder illustrating and describing friction drum hoists and [illegible] with [illegible] drive.

Redwood Lumber.—Pacific Lumber Co. of Illinois, 332 South Michigan Ave., Chicago. Booklet describing the methods and results of advertising redwood lumber. It is an interesting account of an extensive merchandising campaign.

Waterproofing.—Truscon Laboratories, Detroit, Mich. The second edition of the booklet "Science and Practice of Integral Waterproofing." The first fifteen pages are devoted to the subject of "Why Concrete Requires Waterproofing." Beginning page 16 are specifications for waterproofing mass concrete, waterproofing [illegible] by the cement plaster coat method and waterproofing cement [illegible].

Foreign Engineering Review Quarterly Issue

ENGINEERING AND CONTRACTING

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Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Managament and Office System

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A British View of American Architecture

Editorial in Concrete and Constructional Engineering, London.

Whether it was coincidence or forethought—we suspect a combination of the two—that synchronized the exhibition of American architecture at the Royal Institute of British Architects with the disarmament conference at Washington, the incident affords a happy augury for future relationships between the great countries; a fact that Lady Astor, M. P., was quick to realize when, in the course of performing the opening ceremony, she said, "I think America and Englind should remember that it is taste that unites countries, not treaties." There is a very close parallel between the relationship of the American to the Englishman, and of American architecture to English architecture. It is no rare event for Americans of more thoughtful disposition to experience, on arriving in England for the first time, a strange feeling of kinship, the visit assumes the aspect of a familiar return rather than a new adventure. So, too, the American architect is at once aware that he is amongst the prototypes of his own great national architecture, for the French influence that is now so marked in American architecture is a comparatively modern growth and dates from the World's Fair of 1893, from which date the great name of McKim emerges, and from thence onwards the influence of the Beaux Arts tradition becomes more prominent. America has assimilated the best from Europe, and, the intervention of the Atlantic giving just that distance of vision necessary for freedom from sentiment, has boldly and splendidly converted it to her own ends. Thus it is that we find in some of the smaller works of domestic architecture a delightful harmony between French and English elements that would be impossible in either of the countries of origin. The transplantation of Gothic, however, does not seem to have met with such success. The reason may be that the beauty of Gothic is so largely the result of its very definite structural limitations, and in its history the gradual surmounting of these limitations is to be traced. Today they have been entirely transcended, owing to the development of new materials, so that to build a Gothic structure, retaining these limitations, becomes an anachronism, to build and to ignore them is a sham.

The Englishman, visiting the exhibition, must have been impressed by the greatness of conception, by the scope, and by the opportunity; for architects are limited by the attitude of their age towards architecture. There is, it is true, a certain interaction; opportunities make architects, and architects make opportunities, nevertheless, it must not be overlooked that in America the commercial asset of a fine building is understood; moreover, there exists among the people what may be termed an architectural consciousness which is gradually being created in England, but the process is slow and laborious, and until it is effected we shall continue to have meanness and ugliness in our midst. Meanwhile, we look with envy and admiration at American work, we are astounded at its scale and its prodigality and at that elusive quality which applies equally to architecture as to mankind, and which, in the latter connection, is referred to as good form. An aspect of this quality is revealed in the extreme refinement of detail. Particularly is this noticeable in domestic work. Care is expended on such details as the exact texture of brickwork and in its pointing, in the moulding of the smallest architrave, and the graining of a door. Everything assumes a proper degree of importance and receives a proper degree of attention. It must not be assumed that the English and the French are the only European influences to be found in American work, often the inspiration can be traced direct to the source of the Italian Renaissance or, as in the Pennsylvania Railroad Station at New York, one of the greatest achievements of McKim, Mead & White, to Imperial Rome, and here and there Spanish elements are to be observed. The rich diversity of treatment is largely the result of climatic conditions which vary immensely in different parts of the country. It is difficult to appreciate the significance of this influence, accustomed as we are to our own so very limited variations, and viewing work gathered together from all quarters of half a vast continent within the confines of a small gallery.

Yet over all there is a spirit of originality. The European elements are made to live again because they are synthesized into something new, virile and expressive of a great architecture-loving people. And this boldness of attack is not limited to the designs, but extends also to the handling of materials. No prejudices are allowed to stand in the way of the use of a material if its efficiency be proved. Architecture is after all subservient to humanity, and must therefore be subjected to a never-ceasing change. It cannot live in the past and serve the present. Thus we find that the American architect is quick to realize the possibilities of concrete as a material for every class of building, and quick to discover and exploit its aesthetic possibilities. Assuredly we have lessons to learn from America, and we shall be helped in our instruction by exhibitions such as the one recently displayed upon the walls of the Royal Institute of British Architects.

The Electrification of Railways

Editorial in The Railway Engineer, London

Everyone connected with railway operation in a practical sense, and presumably all who have even an indirect interest in the subject, must realize that, so far as it is possible to foretell, steam will be superseded by electricity as a means of propulsion. It is just as certain that the supersession will be a gradual one, and that very many years must necessarily elapse before, if ever, the steam locomotive disappears altogether.

This class of engine has played an all important part in the evolution of railways, and after something like 100 years of practical utility it is even yet capable of improvement, and may, before being finally abandoned, assume characteristics which at present have not been developed to the practical stage. Nevertheless, those who regard the coming of electric traction in anything like a general form, as something about which it is unnecessary to concern oneself yet awhile, may find much to reflect upon in the paper on "Railway Electrification" contributed to the proceedings of the North-East Coast Institution of Engineers and Shipbuilders towards the end of last year by Sir Vincent L. Raven, Chief Mechanical Engineer of the North Eastern Railway. Had the paper emanated from an electrical engineer pure and simple, it could, perhaps, hardly have been more favorable to the electric system, for although the author in his opening remarked that "in considering the substitution of electric for steam locomotives it will be evident that there are a number of prominent features in both types which are perhaps best expressed by the terms 'for and against,' or 'advantages' and 'disadvantages.'" One may, on reading further, be excused if he arrives at the conclusion that the bulk of the evidence is rather against than for the steam locomotive and generally in favor of the other type.

It would, perhaps, be beside the point to contest the statements made in the paper as to the mechanical disadvantages of the steam locomotive, especially where some of the limiting factors are concerned, but, on the other hand, there is something to be said in defense of the steam locomotive, and more or less in reply to such points as "the locomotive being a complete individual unit, its power cannot be greater than the capacity of the boiler." It seems only fair to remark that, owing to the very fact of the steam locomotive being completely independent (of outside sources) for its power, the results in the event of failure affect only the one individual engine, whereas with electric traction traffic movement on the whole of a section may be paralyzed by a breakdown at the point from which the energy radiates.

Sir Vincent Raven's long experience as a locomotive engineer coupled with his knowledge and practice in connection with electric locomotives and traction systems, makes anything that he may write or say upon the subject well worthy of attention, and although on the surface the paper appears to relegate the steam locomotive to a position of inferiority, there is, as a matter of course, nothing in it which can be characterized as misrepresenting facts regarding a class of engine which has for so many years past been, and must for many years remain the one upon which the all important function of hauling trains on railways devolves. * * * * It will, we think, generally be conceded that Sir Vincent has rendered an important service in thus adding to the literature of the subject a paper which has the merit of conviction and is based on practical experience gained in the wroking of some of the most difficult railway traffic in the country by means of advanced types of steam locomotives, with, in addition, a by no means small acquaintance with electric traction both at home and abroad.

The Civil Engineer

From an Editorial in Engineering, London

That engineering continues to be an art rather than a science is a legitimate deduction, from the importance attached to practical experience, in the able and interesting presidential address which Mr. William Barton Worthington delivered to the Institution of Civil Engineers on Nov. 2. Mr. Worthington directed special attention to the importance of maintenance work and to the influence which experience in repairs and renewals exercises on the design of new structures or appliances. Occasionally, no doubt, such work calls for the exercise of the highest powers of imagination and executive skill, but when these circumstances arise the work is apt to be so strenuous as to preclude the over wrought and harassed engineer from properly appreciating its inherent interest. The experience gained in such work is, however, simply invaluable, and many engineering catastrophes may be traced to the lack of such training on the part of structural designers.

Of late years far too many engineers have been reluctant to admit that an empirical factor is involved in fixing the scantlings of roof and bridge members, and have been prone to assume that a knowledge of stress analysis is all sufficient for the proportionment of bridges, roofs and cranes. One result has been such discreditable failures as the collapse of the giant cranes provided for the Panama Canal. A maintenance engineer learns much that he could never acquire in the office. Loose rivets or buckled plates will teach him, for example, that the stiffening of a member is on the border line of danger, a fact which the office man may learn only through a complete and possibly disastrous failure. Amongst the points now specially attended to as the result of experience Mr Worthington noted the care taken to provide that all steel work not permanently protected from the action of air and damp shall be readily accessible for painting.

Though in some minor details of this kind the designs of our railway pioneers have proved defective, the really astonishing point is the extraordinary endurance shown by structures they built at a time when the weight of a complete locomotive was in some cases less than that now concentrated on a single axle. Of course, many bridges have had to be completely replaced, and Mr. Worthington noted in particular the laminated timber arched viaducts introduced by Joseph Locke on a number of railways, for which he was responsible. Ultimately all of these had to be replaced after a life of from 16 to 28 years, whilst some stone arches of similar span erected at about the same time by Vignoles are still in use, and at the most have needed nothing more than the strengthening of the spandril walls against the pressure of the filling. Mr. Worthington in this connection raised the difficult question as to whether it would not have been better to have avoided the use of non-permanent materials in the first instance, and from the purely actuarial standpoint the answer would, no doubt, be in the affirmative. The matter is, however, not to be settled so simply. In the United States, for example, the community was confronted with the alternative of having either cheap railways or no railways, and very wisely accepted the former, in spite of the attending drawbacks of large charges in subsequent years for maintenance and replacements.

Mr Worthington has an hereditary interest in the old timber bridges above referred to as his father worked much overtime on the designs, on various occasions not getting away from the office till ten or twelve at night. With so little precedent to serve for guidance, work of this character must always have necessitated long hours of arduous thought, and in fact the same remains true of every really new development in engineering where success is, in general, only attained by heavy toil done out of ordinary office hours. In one respect the engineers of the period in question had an advantage over those engaged in corresponding work today. The labor problem was less insistent. The proletariat had not had time to forget the hardships and constantly recurrent famines of the pre-capitalist period, and so far from regarding as natural enemies those engaged in developing the resources of the country, are reported in more than one instance to have offered a week or a fortnight's work free.

when the alternative was the immediate abandonment of an enterprise on the verge of success. Today, whilst confronted with technical problems quite as complex as those solved by our pioneers, the engineer has to devote about half his time to labor difficulties, and in some callings, in particular, that of mine manager in the northern area, there have been repeated cases of nervous collapse from the resultant overstrain.

No doubt in the old days too little consideration was given to the human element in industry, and labor was dealt with almost as if it were a mere commodity. That that condition of affairs has disappeared is a gain, but the pendulum has swung too far in the opposite direction. Grievances either imaginary or, at the most, providing an occasion for a conference or a compromise have been made the excuse for disastrous strikes, which by the consequent destruction or non-creation of wealth have necessarily lowered the average standard of living of the commonalty. At the same time they have greatly increased the burden on the engineer.

We have heard a power station superintendent declare that the troubles consequent on the coal strike lopped ten years off his life. His stokers struck rather than handle Belgian coal, and the whole tramway service of a large area was threatened with a stoppage in consequence. The service was, however, maintained, but, as is usual, the general public knew nothing of the man to whom they were indebted for salvation from such serious inconvenience. No doubt where an undertaking is in private hands labor of this kind not infrequently receives some special recognition by the directors and shareholders, but in the case of a municipal undertaking there is more than a possibility that the engineer's sole reward will be a sense of duty done, which may be largely offset by the fear that this will, by one or other of the various political parties, be counted against him for unrighteousness. Mr. Worthington referred in his address to how little show the engineer makes in the public eye, but this is an old story.

In the United States matters—according to Mr. Waddell—are at present as bad, if not worse, than here. Mr. Worthington, in one part of his address, observed that civil engineering cannot be thrust upon a man, but according to Mr. Waddell this has actually occurred in America, where a lawyer was appointed State Engineer on the ground that the office must be held by a competent politician. Between the modes of thought of the average politician and the engineer there is a gulf as great as that between the mentalities of Jubal and Tubal Cain. The former, we are told, sang of the impassable seas, which Tubal Cain forthwith proved to be non-existent by inventing the boat, to the great annoyance of the discredited seer.

Sewer Gas

Editorial in The Surveyor, London

Since it was discovered that the supposed disease producing properties of sewer gas have been greatly exaggerated, comparatively little attention has been given to the dangers to life which, apart from any question of disease germs, are present in sewers and sewage tanks. The excellent paper read by Mr. H. C. Whitehead, chief assistant engineer, Birmingham, Tame and Rea District Drainage Board, before the Institution of Municipal and County Engineers, draws attention to these dangers. It is probable that Mr. Whitehead's work will save the lives of many persons who have to work in sewers. The author draws our attention to the possibilities of poisoning by sulphuretted hydrogen, suffocation through lack of oxygen and injury caused by the ignition of inflammable gases, which gases include coal gas entering sewers through leaky gas pipes and petrol which often finds its way into sewers owing to carelessness or accident. It is clear that the old method of testing the air in a deep manhole by lowering a lamp is, under present conditions, extremely dangerous and likely to lead to an explosion. It would be a mistake to imagine that these are alarmist ideas. A careful study of the reports of inquests will show the need for greater attention to this important subject. Moreover, as the author very clearly shows, it is possible to avoid dangers by taking simple measures of precaution. The presence of sulphuretted hydrogen is readily detected by means of lead acetate papers, which are easily obtained. If one of these moistened papers is lowered into the manhole, and it darkens within a minute, sulphuretted hydrogen is present in fatal or dangerous quantities. The test for lack of oxygen is made by lowering a safety-lamp into the manhole, and if it goes out within two minutes it may be assumed that there is insufficient oxygen to support respiration. This test is safe. Though it is sometimes possible to live and breathe without much difficulty in air which will extinguish a lamp, it is very unwise to take the risk of doing so. The presence of inflammable gases is to be detected by means of a "detector" type of safety lamp, as used in coal mines. Some engineers who are accustomed to smoking in sewage tanks may be sceptical when they hear that smoking in sewers or sewage tanks should be absolutely forbidden. The habit may be extremely dangerous, but it is by no means uncommon, and it would be of interest to carry out an experiment in order to see whether it is possible to ignite an explosive gas by means of a pipe burning tobacco. Probably the objection to smoking is in the possibility of matches being lighted in the sewer tank.

The above considerations certainly show that the need for ventilating sewers is greater than is generally supposed. Further, the construction and the design should receive consideration in order to ensure that nothing is done to cause the generation of gas; thus, manholes containing back drops or junctions between high and low level sewers, settling tanks, storage tanks, tank sewers and covered sewage tanks of all kinds are obvious sources of danger unless proper steps are taken for the protection of those who have to work in them. Mr. Whitehead drew attention to the dangers from trade wastes, a point which was emphasized by Mr. J. D. Watson in the discussion. The wearing of gas masks in sewers was referred to by Mr. Meek, the city engineer of Manchester. It appears that in that city the sewer men find such great discomfort in working in masks that it is doubtful whether the method is a success. Other speakers referred to the great dangers due to the discharge of petrol into sewers, a matter needing special attention and prevention.

Wages and Costs

Editorial in Times Engineering Supplement, London.

In the memorandum on the earnings of labor and costs of production issued last week by the Federation of British Industries on the report of the Production Cost Sub-Committee of the Federation's Trade Depression Committee the statement is, in effect, repeated that when other causes tending to depress trade have been removed we shall compete successfully with other countries only if our real costs are comparable with those of producers abroad. By far the largest element in costs is wage cost, which includes what is paid not only to the industry directly in question but to other industries—fuel, power, materials, machinery, transport—whose services it has to employ. To bring costs to a level at which the maximum of relief may be found for unemployment either a larger output is required for the wages paid, or lower wages must be accepted, or perhaps longer hours worked. The alternative—not of the employers' contriving or seeking, and one that causes them direct loss or even ruin—is no employment and no wages at all. The report admits candidly that no one can foresee accurately how much sacrifice will be required to reach the necessary level of cost, and it appeals to all concerned to make the sacrifice with the enlightened readiness that will most rapidly alleviate the present distressing situation and open the way to the renewed attainment of prosperous conditions. In particular, it urges that reduction of wages, increase if desirable of hours, and whatever other aids to improve output may be possible should be as widespread and be made as rapidly as possible. If they are made by a few industries alone they will do little to reduce the general level of prices on the home market, and the industries in question will be losing in wages without the corresponding rise in the purchasing power of wages by which the sacrifice might to some extent be offset. The term sacrifice which the report uses is perhaps not altogether happy, for it suggests the abandonment of what at will might be retained. The sacrifice of wages and any other means of reducing cost is not such a voluntary abandonment. It is rather in the nature of jettison, by which a ship in danger of wreck throws commodities or gear overboard which in normal weather its business is to retain.

Relationship of Pumping Plant to Reservoir Capacity

Editorial in Municipal Engineering and Sanitary Record, London.

In designing works of extension of mains for the supply of water it is necessary to make provision for coping with the maximum demand which may occur at any time. Records of consumption where such are available show that at times the demand exceeds the average by very large amounts, but such excess depends upon the period under consideration. Taking the average rate of consumption for any period throughout a year as 100 the rate during one maximum hour may be two and a quarter times as much or, say, a rate represented by the figure 225; the rate during a maximum day may be 50 per cent above the average, or, say, 150; during the maximum week, one-third more than the average, or, say, 133; and during the maximum month, one-fourth more than the average or, say, a rate of 125 during each day of the month. The precise figures will vary in different undertakings, but they will exhibit the same general characteristics. When the scheme is a pumping one the question which at once arises is the extent to which the peak load should be handled directly by the pumping plant. Generally it may be said that if the pumping plant will deal with the average flow, variations in demand can be met by the equalizing reservoir, which it is essential should be provided, but in some cases it might be more economical to increase the pumping plant above the average, which would enable the reservoir capacity to be reduced. On the basis of the figures previously given, and assuming that the reservoir has to cater for all above the average flow, then the maximum daily flow which might occur on two successive days would require a reservoir capacity equal to one day's average demand. To cope with the maximum week with an increased flow of 33 per cent for each of seven days would require a reservoir holding 2 1/3 days' average demand. To deal with the maximum month with an increased flow averaging 25 per cent for each of thirty days would require the reservoir to hold 7½ days' supply. The reservoir in this latter case would be comparatively large and expensive, and it might easily be more economical to increase the capacity of the pumping plant. The exact relationship to produce the most economical result can be obtained by assuming certain capacities and preparing comparative estimates. It need hardly be said that it is undesirable to rely upon the reserve plant to meet contingencies which it is well known will occur at more or less regular intervals.

Water Purification by Activated Silt

Editorial in The Surveyor, London.

In the Journal of the Indian Institute of Science for 1921 there is an interesting article on the "Purification of Water by Activated Silt," by Dr. Gilbert J. Fowler and Mr. R. R. Deo. It appears from this that Dr. Fowler, when in China a few years ago, was struck by the fact that although practically the whole of that vast country is manured with night-soil and intersected by creeks so that much impurity reaches the Yangtse and its tributaries, "apart from the presence of [illegible] and of organisms of the coli groups, these rivers as a whole and apart from special localities could not be described as being seriously contaminated. The pollution to which they were obviously subjected appeared to be very rapidly oxidized." He states that this power of purification was to be found in the large amount of fine silt carried by these rivers, each particle of silt acting as a base for the necessary bacteria." This silt was discovered on examination to be "of a [illegible] nature which hangs suspended in the water for a considerable time." Dr. Fowler came to the conclusion after a careful study of these phenomena that this natural action might be imitated artificially in a manner analogous to the activated sludge process of sewage purification, and he proceeded to make exhaustive laboratory experiments on the proper [illegible] of silt to be employed to produce the best results and the proper means of applying the process for the purification of water. These experiments and analyses are set forth in the article but are of too great a length to reproduce. The authors do not appear to have come to any very definite conclusions as to the merits of the scheme for the purification of water by [illegible] as a means, but we are much struck with their opinion or remarks with regard to Dr. Fowler's scientific observation of the remarkable effect of the fine silt on the purification of the rivers he inspected, and the manner in which his trained mind deduced the cause of this purification. There are still existing many natural phenomena, the reasons for which we are yet unable to explain, but which, no doubt, the scientific mind will in course of time unravel, and it is just such investigations and researches as those carried out by Dr. Fowler and Mr. Deo which often produce far-reaching results in the material progress of the world.

The Preservation of Stone

Editorial in Municipal Engineering and Sanitary Record, London.

The atmospheric impurities in our cities acting in conjunction with the devouring hand of time render it imperative on us to do something promptly towards the preservation of our noble public buildings. By using gas more largely in substitution for coal, and otherwise ensuring the proper combustion of coal, we can relieve the atmosphere of most of its impurity and increase our own comfort while we are removing some of the chief causes of the decay of stone, but some decay will nevertheless go on. Although the greatest scientists and geologists of the day were called in to select the stone for building the present Houses of Parliament, the condition within twenty years was such as to cause serious alarm. From that time to the present, H. M. Office of Works has given continuous attention to the subject of the preservation of stone, tested all manner of preservatives but has not yet been able to find any sure means of warding off decay. It is most rapid in the case of traceried windows and mouldings where the stone has been worked after the quarry sap has reached and hardened the face, and that shows why wall stones are not affected so much. Another cause of rapid deterioration in individual wall stones is found to be due to their having been laid with the quarry bed on the face, instead of on their natural bed as the specifications always insist, but which is not easy to determine at the time with certain classes of stone. There is also something in the physical structure of the stone which affects the question, that has not yet been determined. For instance the chemical composition of Bath and Portland stone is almost identical and yet the durability is vastly different. The preservation of old buildings where decay has already taken place is infinitely more difficult than the protection of new ones, and much labor and thought have been expended on this aspect of the case, with only modified success.

Stability of Thin Walls

Editorial in Municipal Engineering and Sanitary Record, London.

The report issued by the Building Research Board is practically that of Dr. Oscar Faber who was entrusted with the investigation. It was a difficult subject, but he appears to have dealt with it in a practical manner. It is generally realized that the actual stability of unsupported walls only a few inches thick is very small and that such walls in practice always receive support either at the top or sides or both. It appeared therefore to the committee that the most practical method of attacking the problem was to ascertain the breaking strength of typical walls when subjected to crushing loads and horizontal pressure applied to the walls while held at the top and bottom. This would correspond roughly to a wall having in it two door openings, the strength of a wall with no openings being somewhat greater. The difficulty of applying loads by directly weighting the walls was realized. It was found possible to secure the use of a hydraulic testing machine which was capable of crushing short walls 8 ft. 6 in. high, which is about the height between floors in a building of the cottage type. Tests were made on several commonly used materials and each material was loaded to destruction in three ways. (1) Small cubes, generally 6 in. or 9 in. square were crushed in order to ascertain the strength of the material when not used as a thin structure. (2) Columns or pillars 14 in. wide, from 2½ in. to 4½ in. thick and 8 ft. 6 in. high. These [illegible] or pillars were crushed and their relative strengths compared with that of the cubes were ascertained. (3) Short lengths of wall 4 ft. 6 in. wide, from 2½ in. to 4½ in. thick [illegible] 1 ton per lineal foot of wall, and while this load [illegible], a horizontal pull was applied to the wall at the middle of its height until failure took place. The [illegible] brought out are the high relative resistance to crushing shown by the slender walls or pillars, and the [illegible] of the lime mortar compared with Portland cement when used in this way. With the exception of the wall built with lime mortar, the crushing strength of the walls varied from [illegible] to [illegible] per cent of the strength of the same material [illegible] as cubes. The lime mortar only showed 30 per cent. The high percentage strength is to some extent due to the care exercised in erecting the column under test. It is, however, clear that strengths approaching these can be [illegible] in practice, provided care is exercised in the bedding of the joists, so that the load acts as nearly as possible through the center of the wall. It is also necessary that the wall should be absolutely vertical. The results further show that the walls built with Fletton bricks on edge in cement ([illegible] in. thick) resisted a much higher crushing load and horizontal pull than those built with the same bricks laid flat in lime mortar (4½ in. thick). All the concrete and breeze blocks show a high resistance to the transverse loads as compared with walls formed from smaller units such as bricks.

An 8-Ft. High Pressure Reinforced Concrete Conduit

From Schweizerische Bauzeitung.

A conduit for the supply of water under great pressure, for the hydro-electric works of Rioupéroux (Isére), has been built of reinforced concrete. The conduit is 2,040 ft. in length, and 8 ft. in diameter. The water-level at the inlet is 1,900 ft. above datum, that at the exit is 1,700 ft., so that there is a static pressure equal to a water-column 200 ft. high. The ends of the conduit are of steel, so as to ensure a perfect connection with the plant.

The conduit pipe has a double transverse reinforcement throughout its length, the steel rods used being ½—⅝ in. diameter, with horizontal tie-rods ⅜ in. diameter, and placed rather more than an inch apart. The joints in the reinforcement are simple hooks, no solder being used. In the bent portions of the conduit extra reinforcement is employed.

The thickness of the wall of the conduit varies from 4 to 8 in. The concrete is a 1:2 mixture.

The centering used for the greater part of the conduit was the "Parapline," which had previously been used in other cases, but for the more difficult of the curved portions wooden centering was used.

The interior was made smooth with a finishing coat 1½ in. thick.

To ensure complete impermeability under the high pressure the greater part of the conduit was fitted with a steel tube which was placed between the two rings of reinforcement, the joints being welded autogenously.

Prior to being used, the conduit was filled with water, left overnight, and then gradually emptied. It was next inspected, with the greatest attention to detail. It was then filled rapidly and examined externally.

A $15,000,000 Water Supply Extension for Sydney.—The New South Wales Parliamentary Standing Committee on Public Works, according to the London Times Engineering Supplement, has urgently recommended the Government to proceed at once with an amplification of the Sydney metropolitan water scheme at a total cost of approximately £3,000,000. The works proposed include a number of new mains ranging from 24 in. to 48 in., a pressure tunnel 10 miles long, and electrically-driven centrifugal pumps in duplicate. The proposed tunnel will contain two concrete tubes each 7 ft. in diameter. It will be about 20 ft. by 12 ft., and in places 170 ft. below the surface. The object of the scheme is to enable the water stored to be brought more rapidly to the metropolis for distribution. It is expected that what are known as the Avon and Cordeaux dams, now in course of construction, will be completed in five years, about the same time as the proposed pressure tunnel and other new works mentioned (if undertaken). If these things are done the demands of the metropolis will be met up till 1932. The works are based on an average consumption per head daily of 100 gal. The existing means of distribution allow an average consumption of only 45 gal.

The "Zaaidam" Method of Irrigation in South Africa

By T. HOPWOOD.

From The South African Irrigation Department Magazine, Pretoria, South Africa.

"Zaaidam" irrigation is practiced to a large extent in the Divisions of Calvinia, Fraserburg and Carnarvon, and the writer recently took a few notes with a view to setting down the methods usually employed and the results obtained therefrom. It is by no means implied that this paper is the "last word" on the subject; on the contrary, it is recognized that there is room for a large amount of experiment and research, especially with regard to the effect of water standing for long periods on soil to be cultivated and also on the water table; further what applies to one class of soil does not always apply to another but the methods of applying the water, sowing, etc., are more or less the same.

"Zaaidam" irrigation simply means impounding water in a large shallow basin, letting it thoroughly soak into the soil, then allowing the surplus water to run either to the next lower "zaaidam" if there is one, or away, and sowing grain in the basin wetted, the crop reaching maturity without further application of water if none is available. It is very similar to the basin irrigation practiced on the banks of the Nile, but with much less certainty as to the time of floods.

The Fish and Zak River valleys where the soil is very fertile, the rainfall low and the country extremely flat, are especially adapted for "zaaidam" irrigation. These rivers, when they run at all, creep along and spread out all over the surrounding county, often to a width of several miles, and as the ground is very flat an earthen embankment a few feet high will cause the water to "back up" a couple of thousand yards or so.

Usually the old method of leading water from one "zaaidam" into another was to breach the embankment, but this method causes a lot of scouring, so control sluices, a type of which will be described later, are recommended.

The embankment, usually from 5 to 9 ft. in height, according to the fall of the ground and the size of the "zaaidam," are constructed of earth which is generally of a very suitable quality. Formerly it was usual in the case of the larger dams to construct the upstream slope about 2 to 1 and the downstream about 1½ to 1 with a freeboard of say 3 ft. The upstream slope would then be pitched with bushes, mostly "kareedoorn," taken from the surrounding lands, as stone of any description was practically unobtainable in any quantity, but the latest practice is to construct the embankments with very flat slopes, say not less than 4 to 1 and omit the bush pitching as it tends to harbor rodents which, by burrowing into the bank jeopardize its safety. In cases where the water will "back up" from a lower zaaidam on to the downstream slope of an upper embankment, and this is the case where it is desired to cultivate the whole of the lower basin, both slopes should be constructed 4 to 1.

When a bank crosses a "leegte," a pipe, fitted with valve or wooden bung, is laid at a low level through it in order to drain off any water which may collect in the low places, one of six or nine inches in diameter generally being large enough for this purpose.

The type of outlet sluice which is in use at the Government dams at Nelskop is known as the "needle sluice" and has proved very effective, being easy to manipulate and allowing a large volume of water to pass into or from the dam in the minimum amount of time.

In most cases four bays, each 10 ft. wide, are constructed, each of which can be opened independently, so that one or all may be used at a time. Concrete piers 2 ft. thick divide the bays and the 9-in. x 3-in. needles which are placed against the lip of the sill are supported at their upper ends by a strong beam resting on the tops of piers which are stepped to keep the beam in position. About half-way up the pier an iron bar with rollers on it is fixed to facilitate the "needles" to be placed in position or removed when there is pressure on the upstream face.

The most suitable size for a "zaaidam" depends largely upon the width of valley and fall in the ground, but it must be borne in mind that one of the chief considerations is the impounding of unseasonable waters, and for this reason a large and fairly deep reservoir is required, but against this is the fact that a small flood will fill the lower portion only, and successive small floods will repeat the operation. Thus, not only will a very small area be available for cultivation, but there is the danger of losing the crop from drowning, owing to the river coming down before the growth is sufficiently high to receive a second watering. On the other hand a shallow "zaaidam" may lose all its water through evaporation and soakage before the time arrives suitable for ploughing and sowing.

The ideal system would be to have a large "zaaidam" storing say a maximum depth of 6 ft. and below that two or three smaller and shallower dams fed from the larger one.

From the point of view of economy both in construction costs and use of water it is found that, taking a hypothetical case of an area 2,000 yd. wide and 5,000 yd. long, with a fall of one in three thousand, the comparison between one embankment 9 ft. high constructed to flood the whole basin and splitting it into two smaller embankments 6 ft. high would be as follows:

(a) In the case of the large Zaaidam:	
Cost	£2,000
Storage capacity, acre ft.	3,167
Area available for cultivation if filled would be, acres	1,653
Loss, if surplus water not used again below, ft.	[illegible]
(b) In the case of two smaller Zaaidams:	
Cost	£1,[illegible]0
Combined storage capacity, acre ft.	[illegible]
Area available for cultivation, acres	[illegible]
Loss, if surplus water not used below, ft.	2.14

Apart from the matter of cost it will be seen that with the exception of having greater storage facilities, which is undoubtedly an advantage as regards holding up unseasonable floods and using the water later, the large "zaaidam" has very little else in its favor. The question of rapid leading from one basin to another can be dismissed, for this is purely a matter of how many sluices are constructed; further, several shallow sluices are less likely to cause scour than a deep one.

The greatest disadvantage in respect of the large "zaaidam" is the fact that in the case of a small flood only the bottom portion of the basin is wetted; that is then ploughed and sown, and, before the grain is high enough to receive another wetting, down comes the river, the lower end of the basin is again submerged and the crop drowned, or if the sluice gates are opened the water is lost, whereas in the case of the smaller "zaaidams" either could be used and every advantage taken of small floods.

Again, taking a flood of say 500 cusecs, it would have to run for over five days in order to fill the larger "zaaidam" whilst three and a half days would suffice for the two smaller ones.

It is easy to see that where economy in water is desirable, and this is practically always the case, the smaller "zaaidams" are to be preferred, if the slope of the ground will permit it. By small "zaaidams" is meant those where the water stands say 2 ft. 6 in. to 3 ft. at its deepest end.

The largest "zaaidam" in the Union is that known as the "[illegible]" owned by the Zak River Estates Co., Ltd., the biggest irrigators on the "zaaidam" principle in South Africa. The dam in question is large enough to place 1,350 acres under cultivation. The Government has several at Nelskop of over 500 acres, but these are sub-divisions of larger basins cut up in order to economize in the use of water.

With regard to the amount of water required to mature a crop, this depends upon the nature of the soil and the amount of care taken to break up the surface by harrowing and rolling in order to retard evaporation by preventing the formation of deep cracks thus retaining the moisture in the soil for the longest possible period. A stiff, clayey soil requires a much longer time for the water to penetrate it than a loose, friable one, and the latter more easily retains its moisture as it is not difficult to break up after sowing.

In giving evidence in the Zak River case Mr. J. N. van der Merwe of [illegible], who has had a large amount of experience in "zaaidam" irrigation said that the soil should receive 12 in. of water plus such an amount as penetrates it while the "zaaidam" is being filled and admitted that he based his estimate on the fact that where the water had stood at 12 in. in the dam the crop was as good as where there was more water, but where there was less it was not so good. It is found that this is borne out by the opinions of several other experienced farmers, but it cannot be over emphasized that the crop return depends so much on the amount of "dry-land" cultivation methods adopted after the wheat is sown. Very little has been done so far in this respect especially amongst the settlers at the Government "zaaidams" at Nelskop near Brandvlei, but where efforts have been made to provide an anti-evaporation blanket, or "mulch" as it is sometimes called, by breaking up and pulverizing the surface, good crops have always resulted, even when no second watering was possible.

As regards the necessity of a second watering, this is not an absolute essential, though when water is available it can be used with benefit, providing the crops are high enough to stand it. Crops in sandy soil may be watered three months after sowing, but those in clayey soil should not be watered under four months. The second watering should not cover the ground for more than a few days, especially if water is warm, cold water may be left in basins up to six or eight days. Water containing a lot of silt should not remain long on the growing crops as the silt tends to settle on the sprouts and retards growth. A little water should, if possible, be allowed to run into the basin before filling it in order to wet the embankment so that any cracks and leakages may be detected and remedied before the bank is under pressure.

The grain usually sown is wheat, the favorite varieties being "ou baard" and "boomsaaier," though several farmers sow a little "magals" which, it is understood, is a Bengal wheat; it produces a large hard grain not suitable for flour, but used in the manufacture of macaroni and also on the farms for making soup. Col. Carel van Zyl of Carnarvon says he has grown this class of wheat with great success. Oats, too, have been sown, but the practice is not recommended as, when the crop is changed to say wheat, the "opslag" from the oats of the previous season ripens and casts its seed before the wheat is ready for reaping, and, consequently, the wild oats take a lot of eradicating the following years.

The yield of wheat under "zaaidam" irrigation averages say eight to ten bags per morgen, and, as the amount sown is one bag to three or four morgen, according to quantity of soil, this gives from 24 to 40 bags for one sown. Instances of much higher yields are known, as for instance 115 bags for one, sown at Diepdrift on the Zak River, and this is by no means a record.

At the Government Irrigation Settlement at Nelskop near Brandvlei the land is let to settlers in small holdings, the smallest being four and the largest seventy-two morgen, the average being about twenty-four, and with this and the right to graze a certain number of stock on the commonage free they appear to make a fair living.

Briefly the best yields are obtained when the ground is first ploughed, then wetted, again ploughed and then sown and afterwards harrowed and rolled several times, and when possible given a light second watering in about four months' time. The ground can be harrowed and rolled until the growth is about 6 in. high.

The questions as to whether or not the water lying in the "zaaidams" for two or three months at a time is harmful to the soil or whether the underground water table is thereby raised, are debatable. Mr. Bain of the Zak River Estates informs me that the water table though it may be raised temporarily always subsides again towards the end of the dry season, and as regards the former point it would appear that though the soil is submerged for a long period the subsequent ploughing and harrowing, provided both are thoroughly carried out, aided by the excessive amount of sunlight in these arid districts, provides sufficient aeration.

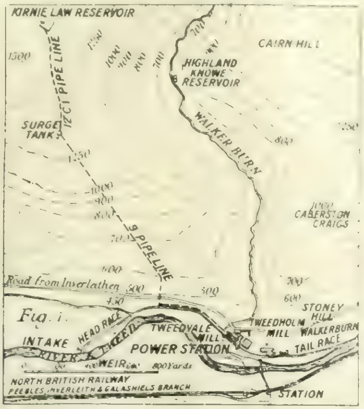
A difficulty, however, is experienced in those parts of basins where only the finest silt settles. This silt cakes hard on drying and cracking, and it is then not easy to work it into a fine mulch.

Instances of "brak" appearing below the embankments after water has been stored for some time have been noted, but where there is an opportunity of flooding this, and then allowing the water to run off, a cure is effected, care should be taken, however, when laying out a "zaaidam" to do it in such a way that all the water can be drained off when desired, this will naturally assist in preventing or curing "brak."

A Water Power Mechanical Storage Installation

From Engineering, London

A water-power installation which possesses many novel features has lately been put into operation, and is now supplying the necessary power for driving the Tweedvale and Tweedholm Mills at Walkerburn, Peeblesshire, England. This installation is so far, we believe, the first of its kind constructed in this country, while only one or two others are said to exist in the world. Water storage is commonly adopted, of course, for the purpose of supplementing supplies in periodic seasons of small natural flow. Lately it has been discussed in connection with tidal power schemes, in order to obtain a regular power supply in spite of the regular precession of the tides. In these connections the possibility of pumping water to a high level during the tidal ebb or flow, and using it subsequently in turbines as required during the period of slack tide has been considered. In the case we are about to deal with pumping and storage have been introduced for another reason. The normal output of power during the working hours has been in this instance largely increased by pumping and storage during the non-working hours of the week and using the water so stored during working hours to supplement the normal supply to the station from the stream direct.

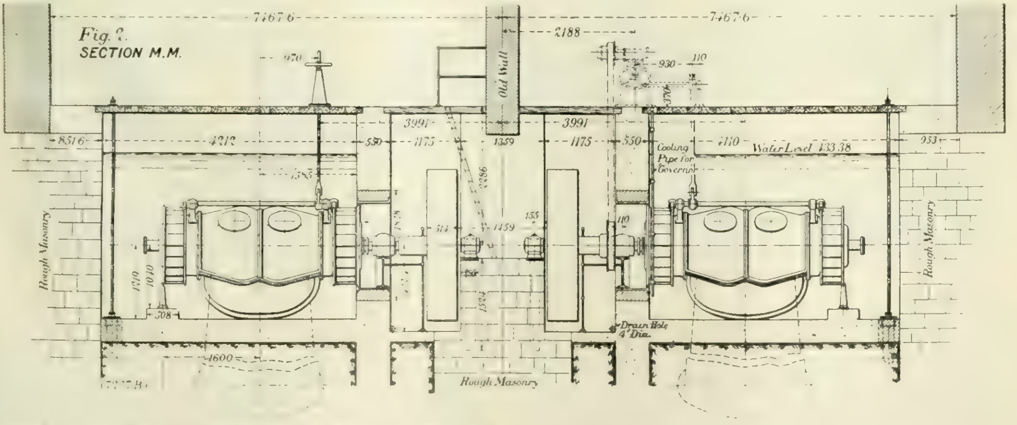


Before describing the present scheme it is interesing to note that this village became a thriving community when these two mills were established in 1854, and that they owe their existence to the water power which was available in the Tweed. For a long time this was the only power used in the mills. The fall available was divided between the two mills, the water leaving the wheels of the upper mill and passing through the wheels of the lower mill before returning to the river. The falls utilized were respectively 5 ft. 3 in. and 5 ft., for although a total head between the intake and the point of return to the river was 15 ft., nearly 5 ft. was lost in the long head and tail races. The mills, which covered a considerable area, had long grown beyond the power available from the old breast wheels, which together yielded only about 110 H.P., and other means of driving had from time to time been added to supplement this water power. A great loss of power in transmission to the scattered buildings by means of long lines of shafting and bevel gearing was unavoidable.

Full development of the water power at the site, however, was impossible until the ownership of the rights for the whole of the fall had passed into the hands of one owner. This change occurred in July, 1918, when Messrs. Henry Ballantyne and Sons, Limited, owners of the Tweedvale Mills, purchased the Tweedholm Mills. Messrs. Ballantyne then decided to utilize the water power available to the best advantage and to eliminate the heavy losses of transmission by introducing electrical driving. Messrs. Boving and Co., Limited, 76, Kingsway, London, W.C. 2, were consulted with regard to a suitable scheme.

The first point decided was that the head available should be developed in one place. The obvious advantages of this were that an economical head would be available for driving the turbines, and the duplication of plant and operating staffs would be avoided. It was decided to concentrate the fall at the upper mill by deepening the race between the two mills, as it was impossible to concentrate it at the lower mill in view of the flooding which would have occurred of intermediate buildings. This involved a considerable amount of excavation. The head anticipated was 10 ft. 6 in., but further improvements in the hydraulic conditions have been made and the operating head is now, under normal conditions, slightly over 11 ft. The size of the existing races is such that their carrying capacity is limited to about 240 cu. ft. per second, and it was not found economical to increase this. Whilst this quantity is normally available throughout the year, there are especially dry years when the flow falls below this figure so that further expenditure in increasing the capacity of the races was not desirable. The power available under these conditions was 220 H.P., which, it will be noted, is exactly double that given by the old breast wheels. A survey of the power requirements of the two mills showed that a total of 450 H.P. was required, and the problem was then to find the balance required, i. e., 230 H.P.

The mills work for about 50 hours in a week, so that for two-thirds of the week the power available would not have been used. With the low head of 10 ft. 6 in. the storage of the water was quite impossible, as the quantity would have been so great that it would have involved the flooding of valuable lands. Electrical storage of the surplus power was also deemed impracticable, and it was finally decided to store the power mechanically, under the following plan, which Messrs. Boving put forward. During the idle hours the turbines were to be run for the purpose of driving pumps. The water from these was to be delivered to a high-level reser-

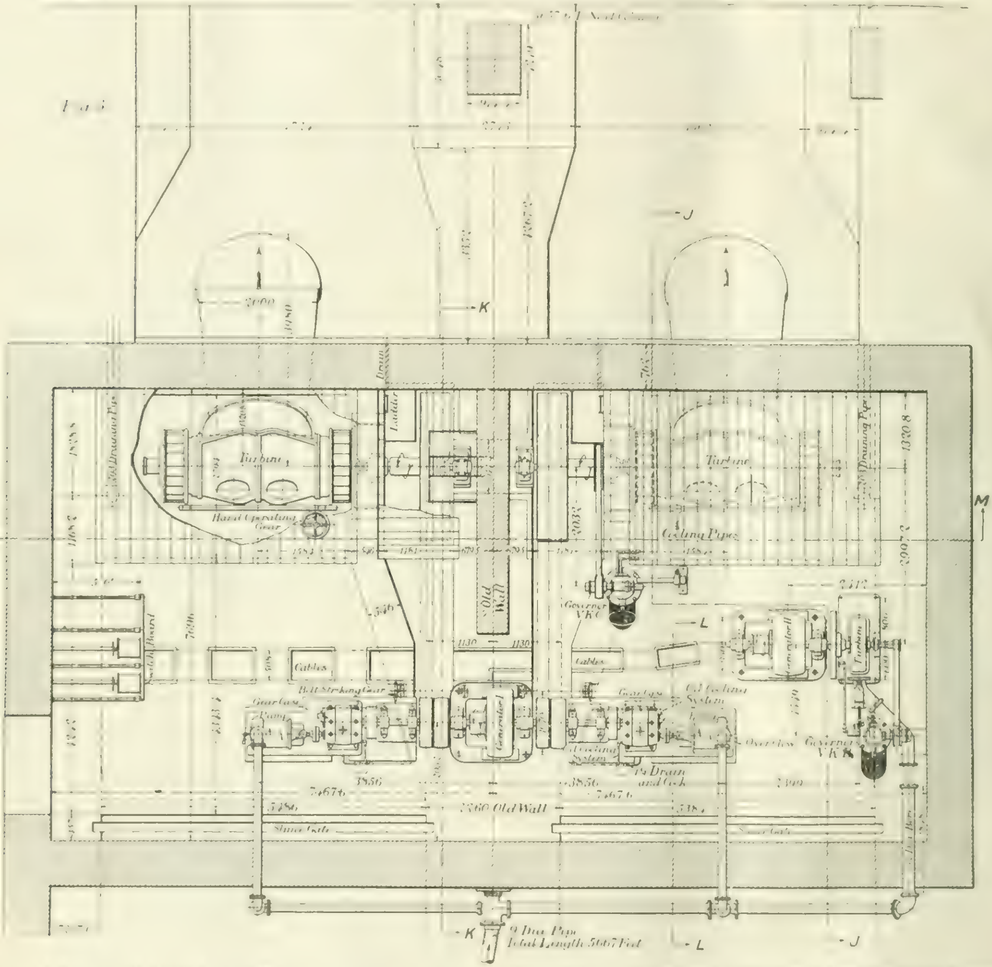


[illegible] had [illegible] for use during the working hours. During those working hours the water stored [illegible] down from the high-level reservoir through the same pipe through which it had been forced up before, and by driving a Pelton wheel would generate the extra power required.

The conditions required for this proved to be quite suitable, as the hills immediately behind the mills rise up steeply to a height of over 1,800 ft. or 540 m. above sea level, and offered an ideal site for the reservoir in contemplation. A general view of the site is shown in Fig. 1. The two mills stand close to the bank of the Tweed, as shown, while the position of the reservoir, the [illegible] pipe line, surge

during the idle hours is absorbed in the pumps, in pipe friction and in losses in the Pelton wheel, the fact that the idle hours are more than the working hours fully compensates for this and enables the effective power to be more than doubled.

The general arrangement of the power station is shown in Figs. 2 and 3, the former being a longitudinal vertical section, and the latter a plan. Vertical cross-sections at various points are shown in Figs. 4, 5 and 6. There are two low-pressure turbines in pits, which drive a generator by belt. Alternatively these low-pressure turbines can be used to drive through intermediate shafts and gears the two high-pressure pumps which force water into the high level reser-



tank and [illegible] steel ejector pipe line connecting the reservoir with the generating and pumping station, are also indicated.

The 9-in. high-pressure pipe had, to save expense, was brought as nearly as possible up the hillside. The reservoir had to be placed on a saddle some little distance away, and it was connected to the top of the high-pressure pipe line by a 12-in. concrete pipe running practically on the level round the contour of the hill. A surge tank was necessary at the junction of the 9-in. and 12-in. pipes to provide for [illegible] at load, for the 9-in. pipe being on a steeper slope [illegible] readily accommodates itself to changes of head and [illegible] draws off more water than the 12-in. pipe can immediately supply.

This scheme provides the extra [illegible] H.P. required, for in spite of the fact that a good deal of the energy available

voir. At one end of this station is a high-pressure turbine direct coupled to a generator. This is used to supplement during working hours the output of the low-pressure machines. Normally the low-pressure turbines are run on full load. Any variation in demand is taken care of by the high-pressure unit drawing its supply from the reservoir. Under these conditions hand control normally suffices for the low-pressure turbines. At night the pumping load is constant, and hand control provides all that is necessary.

The low-pressure turbines are horizontal Francis machines of 110 H.P. each, running at 200 r.p.m. Between the two turbines are a chamber and belt race. The turbine shafts project through watertight bulkheads into this chamber where each is fitted with a belt pulley of double width having a diameter of 100 in. The outlets from the low-pressure turbines are inclined as shown in Fig. 4 in order to reduce the amount of alteration necessary to existing buildings, and give a cleaner exit for the water. Both these low pressure turbines drive on to a single generator of 145 kw., running at 600 r.p.m., each end of the generator shaft having an overhung crowned pulley for this purpose. The duplication of the low-pressure turbines has a considerable advantage, apart from overhaul. On occasions it is necessary to work overtime, when the central generator can be driven by one turbine, and for this one turbine is provided with a governor. The other machine can be belted to the pump supplying the reservoir, and worked on hand regulation.

In line with the generator driven by the low pressure turbines are shafts carrying crowned pulleys exactly similar to those on this generator, as shown in Fig. 2. These shafts drive the high-pressure pumps which are employed to raise the water to the level of the reservoir, which gives a head of 1,050 ft. During the idle hours the turbine pulley belts are changed over from the generator pulleys to the pump pulleys. The quantity of water delivered by each pump is relatively small, i. e., 220 gal. per minute, and it would have been impracticable to have run them at a speed of 600 r.p.m. A gear drive was therefore resorted to, the turbine pumps being arranged to run at 3,000 r.p.m. To isolate the gear case and prevent any side pull interfering with the correct meshing of the gears, flexible couplings are provided on each side of the gear-boxes. These high-pressure pumps deliver through 4-in. pipes into a bus-pipe immediately outside the power house wall (Fig. 3), and this bus-pipe is connected both to the 9-in. high-pressure pipe leading up the hill and to the reservoir, and the 6-in. pipe for supplying the high-pressure turbine.

The high pressure turbine is of the Pelton type, and under an effective head of 897 ft. develops 230 H.P. This Pelton wheel runs at 1,000 r.p.m., and is coupled direct to a 155-kw. generator.

Owing to the long pipe line, precautions had to be taken for dealing with the water-hammer effect on suddenly shutting down this turbine in the event of the load coming off, and the Boving system of combined needle and deflector regulation has been therefore adopted. In this, as is well known, on load coming off, the deflector cuts into the jet of water issuing from the nozzle and throws the power off the wheel. The needle is then allowed to move slowly forward to reduce the jet to the size corresponding with the new load, and the deflector returns to its position immediately above the reduced jet. In this way the waste of water only takes place during the few seconds of the regulating period. The rapidity of the action of the deflector and the economic control by means of the needle are thus combined.

The whole electrical system is direct current, and the pressure adopted is 250 volts, the switchboard for distributing this being accommodated at the end of the machine room.

Fig. 4. SECTION J.J.

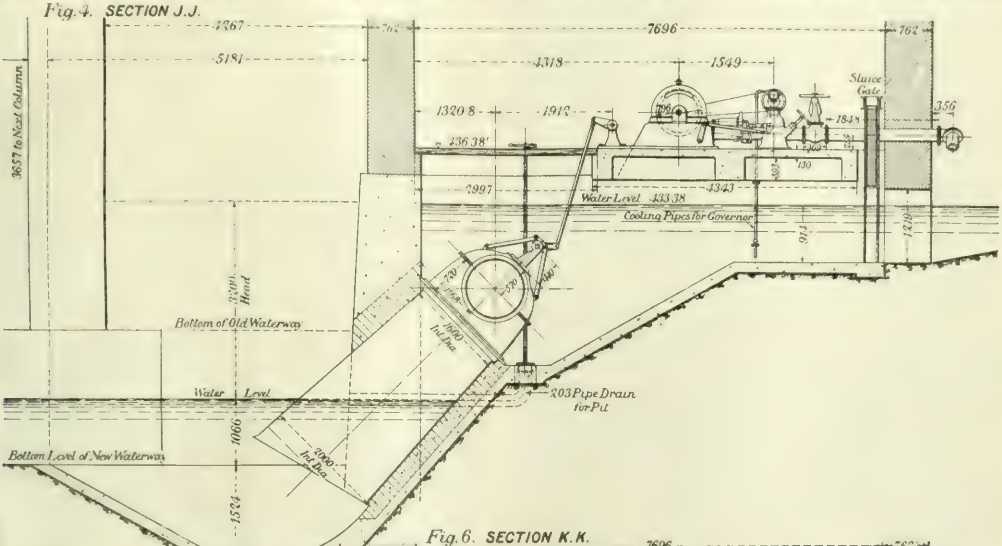


Fig. 5. SECTION L.L.

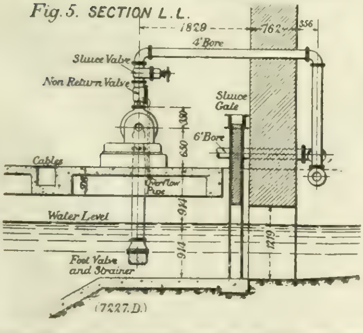
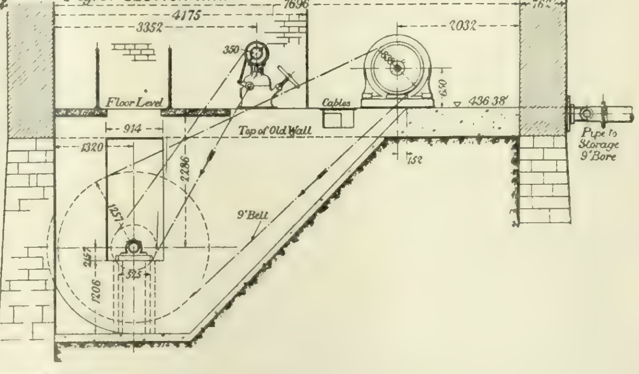


Fig. 6. SECTION K.K.



Trade Disputes in Great Britain in 1921.—The number of trade disputes causing a stoppage of work reported to have begun in 1921 was 800. The total number of work people involved in these disputes (including those thrown out of work at the establishments where the disputes occurred) was nearly 1,800,000, and a further 30,000 were involved in disputes in progress in 1921 which began in 1920. The aggregate loss of working days in all disputes, according to The Labor Gazette, London, in 1921 was about 86,000,000.

Keeping Records and Accounts for a Small Sewage Works

By PERCY LAGE

[illegible] Works, [illegible] Association of Managers of Sewage Disposal Works.

The subject of this paper is one which concerns the sewage works manager very intimately.

Importance of Accounting Methods.—In the case of large works where of necessity a clerical staff is employed the method of keeping of statistics and records is not so important as it is to the manager of a small works, who, as often as not, has to do his own clerical work, and it is these smaller works to which I refer in this short paper.

The records and accounts for a small works must necessarily embrace the same subjects as those of the largest works, and therefore, if they are to be complete, the methods employed must be of a simple nature, as otherwise a large portion of the time of the manager, which should be devoted to supervision, would be taken up by clerical work. This should be avoided as far as possible. The simpler the system the farther it can be extended, and every manager should endeavor to establish such a system to suit the special requirements of his works and make it as comprehensive as possible. Obviously the working and results of the various units in the works must be recorded. Accuracy is essential, and well-bound books should be used.

In many small works the manager will have a register provided by the surveyor under whose control the works are, and therefore he will not be able to use his own discretion as to how that book should be arranged, but as he will have to provide the data to enter, it is up to him to have a simple method of doing so. In a works where the flow is by gravitation and where few changes take place in the conditions of the plant, it will not be necessary for him to have any supplementary aids in compiling data, but where there is a pumping station, operating night and day, no manager can keep correct records unless he has some method of compiling the necessary data in addition to his official register, and the work will have to be carried out with the cooperation of his staff, as he himself cannot be at the works day and night.

Meteorological Records.—The items generally met with first in any record book are the meteorological records; these are well known, and require no explanation, the only difficulty being that they must be recorded at a fixed time, 9 a. m. each day.

Statistics of Various Units.—Then comes—or should come—a record of the working of each unit, whether pump, tank, filter, screen, etc., which is used for the purpose of purifying the sewage. The keeping of such a register is no easy matter, and it is here that the manager must have the co-operation of his staff.

Keeping of Accurate Records.—Where there is but little machinery, or where changes in operation are few, the simplest method is to have the times of starting and stopping each unit or putting in operation a tank or filter, entered into an ordinary plain ruled book, from which the details can be transferred into the register. Where, however, there is a pumping plant or a number of units whose operations change often, such a system is useless. My first attempt to record the operation of the pumping plant under my control, showed me that the booking was not only unreliable, but a number of entries were not made and it became obvious to me that it was necessary to have some simple printed form for the staff to fill in. After many attempts I devised a log sheet, which for my works has answered admirably. On each sheet was a space to enter the times of starting and stopping each unit under that particular man's control, so that if a certain machine was at work, the time it started would be stated, if it had been stopped that time would also appear, and where the plant was at rest there would be a blank, so that I or the man in charge, with a glance at the sheet, knew at once if the entries were in order. These log sheets were made up [illegible], covered at one edge with a stiff strawboard back, and so that each sheet could be easily detached when completed.

Method of Recording Results.—The results of the operation of the plant should be entered on the sheet, i. e., the volume of sewage pumped or treated in each tank, or on each filter, an idea of its nature and also the quality of the resultant effluent from time to time. All up-to-date works have a flow recorder, and others have a weir where the flow can be ascertained, and if in the latter case readings are taken periodically a good idea of the volume can be obtained, but in any case it is an advantage to have readings taken at certain stated periods, say, every three hours, and at the same time a note taken of the nature of the sewage, and where practicable that of the effluent; the latter can be well estimated by using Dr. Thresh's method, by means of a graduated glass and chequered plate. These processes tend to keep the man in charge alert and interested in his work. Spaces on the sheets should be provided for these entries.

Working Costs, Fuel, Repairs, Etc.—Where motive power is used the manager will require to know what it has cost him to provide such power, and, if possible, the cost of driving each individual machine. Where the power is electricity it is quite simple, as all that is required is to provide a meter for each unit and have the readings entered each shift. If only one meter is employed, a recording wattmeter would give nearly as good results in any case. Such an instrument is a splendid check on the booking and men's work. Where power is obtained by steam or suction gas engine, coal, water, etc., must be recorded each shift, not only to obtain the cost, but also to eliminate waste and in the case of steam boilers, to test the efficiency of the stoking. The only accurate method of keeping account of coal consumption is to have the coal weighed as it is used. With slack coal, such as is generally used, it is quite easy to obtain the weight by volume, a special barrow being used for the purpose, say one which just holds 2 cwt. of coal when levelled off, and the number of barrow loads noted. It is quite easy for a manager to check from time to time if the quantities are entered correctly. In the case of suction gas plants, where a less quantity of coal is used, if it is fed into the hopper by means of a bucket or hod, the quantity can easily and accurately be obtained. In regard to oil, a pint measure is all that is required, and the amount taken from the oil cabinet is entered. All articles taken from stores should be entered on the sheet, so that the manager can obtain the cost of running his works each day if he so wishes. To complete the log sheet a time-table of all operations which occur at stated times should be included, with general instructions in regard to the working of the plant, a separate space for "remarks" for each man, and a place for his signature certifying that his entries are correct.

Similar sheets should be used in the other departments, and the details transferred to the official register; other items, such as results of chemical analysis, etc., would be entered from the manager's own data. If such a system is used a manager will find the keeping of his register a fairly simple matter, and his staff will find it a great help.

Where plant of any description is in use the history of that individual piece of machinery, filter, etc., should be recorded in a book kept for the purpose. In the case of a machine, the cost, date purchased, from whom, size, number, etc., speed of working, horsepower required and similar details, should be entered. The dates at which a machine was dismantled for cleaning, etc., and a record of all breakages and repairs, with cost of same, should be entered. Similar records should be kept for tanks, filter beds, etc. At the end of each year the amount of work each unit has done could be entered to make the record complete. Such a book is invaluable to a manager, and more so to his successor.

Labor Costs.—The manager has now to obtain the cost of the labor which the various operations incur. In the first place, every manager should see that he is provided with a time recorder. It is a necessity to every works, and an expense to which no sewage works committee should object. I will assume that every works is provided with one.

Wages Book.—This should be suitably ruled for each man's time and wages due to him, the total being the cost of labor each week, from which the pay sheet can be made out. But should the cost each day be required to be entered into the works register, it will be necessary to make certain modifications. The staff can be separated into various divisions, such as engine men, screen men, outside men, etc., with a summary giving the cost of each division each day, which would most conveniently be entered into the register at the end of each week. Such a system is satisfactory as long as men are employed in purification work only, but if and when it becomes necessary to keep separate costs of different classes of work a different or extended system is necessary. Now, very few manager will be able to find the necessary time to keep a set of books which will give them the cost of any particular job they wish to keep separate, such as the cost of cleaning a certain filter, or constructing a new one, etc., or even of dividing up the ordinary works cost under separate headings. A simple system I used as occasion demanded was as follows: The men were paid by the day, so I took a different letter for each class of work I wished to keep separate—P for purification, M for maintenance of grounds, W other works, such as new filters, sludge beds, etc., and so on. One of these letters I put in the columns opposite a man's name each day, in accordance with the work he had been doing. If he only worked half a day I put P 2. These particulars were obtained from a diary in which the work the men were engaged on was entered day by day. This was all summarized at the bottom of the sheet, and the cost of each class of work so obtained. The amount each week under the items marked W were entered into a ledger, the number of the folio being attached to the letter on the sheet. The system was extremely easy to keep up. The ledger had two cash columns, one in which I placed cost of wages, the other, cost of materials, which were transferred from the "Goods Received" book.

As I stated previously, such systems as I have described are only able to deal with ordinary sewage purification work, but there are a number of managers who carry out side lines, and require to keep accurate costs of each, and when this occurred in my own case I found it necessary to alter my system. I then introduced time sheets for the men, as I was no longer able to keep note of each man's work without some such aid. Then I scrapped my wages book, and the one I now use has on one page the time worked (now in hours), and the total cost, including insurance. The other side of the page was ruled off into cash columns, a column being taken for each separate department, and each man's wages analyzed according to the time sheets, each item being totalled up each week and cross-checked, the amounts, where necessary, being transferred to the ledger as before. I can now quite simply keep the cost of any constructional work, etc., which comes along, and I also have, by carrying forward the totals each week, the total expenditure in wages of any department to date, without recourse to any other ledger, and the amounts are periodically transferred by the accountant to the separate items in the yearly estimates. Thus I am able to work out the wages for 25 to 30 men and analyze them in about an hour.

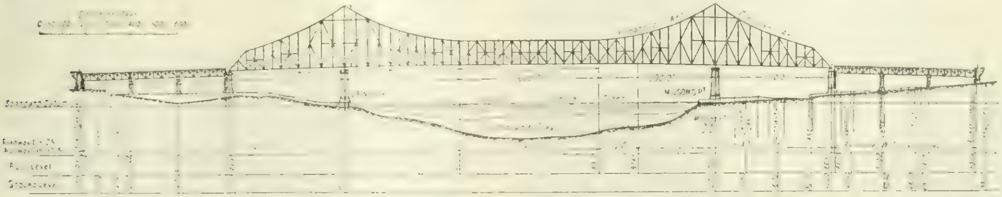
Materials Register.—It is necessary to keep a register of all materials which come into the works. This register can be devised on similar lines to the wages book. The materials and cost are entered on one page; the other page is divided into cash rulings and the amounts entered under separate headings corresponding to those in the yearly estimate, so that expenditure can easily be noted, and the items transferred to the ledger, as in the case of constructional or special work. By these means any manager can keep a complete system of accounts himself with the expenditure of quite a small amount of time. Where goods are sold, of course, a system of bookkeeping must be introduced, when clerical assistance will be necessary; but this is not within the scope of my paper.

House Prices Past and Present in Great Britain.—The remarkable drop in prices, which is one of the most significant signs in connection with modern housing schemes, compared with those planned and carried out but a comparatively short time ago, is clearly indicated in the case of the Swansea scheme. The houses still to be erected will cost about £551 apiece, as compared with £750 for houses under the earlier scheme.—From Municipal Engineering, London.

New 3,800 Foot Bridge at Sydney Harbor

It has now been decided to proceed with the construction of the long-projected bridge across Sydney Harbor from Dawes Point on the south to Milson's Point on the north. According to the Times Engineering Supplement, bids to be delivered to the Under-Secretary for Public Works at Sydney, New South Wales, by Oct. 31 next, are being invited for the whole of the work, including the manufacture, supply, and delivery of the metal work and the construction and erection of the bridge ready for traffic. The time allowed for completion is seven years.

The total length of the main bridge and approaches for which bids are invited is 3,816 ft., center to center of abutments, measured along the center line of the bridge, which is straight except for a curve of eight chains radius in the northern approach. The main bridge is to consist of steel cantilevers spaced 98 ft. 6 in. apart, with shore and harbor arms each 500 ft. long, the harbor arms to support a central span 600 ft. long. The clear span from center to center of the main piers is to be 1,600 ft. The cantilevers and the suspended span are to be "M" braced, with each main panel divided into four. Between the main trusses the bridge is to carry (1) four 4 ft. 8½ in. railway tracks, each spaced 12 ft. apart center to center, with a side clearance of 7 ft. 6 in. from the center of the outermost track to the nearest portion of the structure; and (2) a roadway 35 ft. wide between kerbs and protected on each side by a steel lattice handrail. Outside the main trusses, and carried on cross-girders cantilevered out, there is to be a motor roadway 18 ft. wide on the eastern side and a footway 15 ft. wide on the western side.



Elevation of Bridge to Be Erected Over Sydney Harbor, Sydney, New South Wales.

As will be noted from the accompanying elevation reproduced from the Times Engineering Supplement, at both the north and the south ends there are to be three approach spans, each consisting of four "M" type deck trusses with subdivided panels, and supporting projecting cross girders to carry the motor roadway and footway. The railways and roads on both the approaches will be on a gradient of 1 in 40, which will be continued to the harbor ends of the cantilever arms, but on the central suspended span they will be level and at a height of 189.52 ft. above mean sea level or standard datum. The suspended span is to have a clear headway of 170 ft. above high water, or 172.52 ft. above standard datum.

The main piers, anchor piers and piers and abutments of the approach spans are to be constructed in concrete faced with granite masonry. The main piers are erected on foreshores which have been reclaimed, and in founding them the solid rock must be reached by unwatering in a coffer-dam or other suitable means, or by the pneumatic process if necessary, as the concrete in the footings below water level must be laid on the solid rock in the dry. The other piers and abutments are well above sea level, and the excavation will be wholly in the dry.

It is provided that, if economy and enhanced appearance can be obtained by so doing, bidders may vary the plans shown in the specification drawn up by the chief engineer, Mr. J. J. C. Bradfield, as regards length of the spans, outline of the trusses, details of bracing, number and pitch of cross-girders and stringers, details of decking and hand-railing, but the salient features must be preserved. The cantilevers, girders of suspended span, cross-girders of main bridge and girders of approach spans may be wholly or partially of carbon steel, nickel steel, or chrome and nickel steel. The details of the construction of the superstructure are left to the bidders.

The New Era of Scientific Management

By H. BAKER

[illegible]

During the late war one of the principal problems to be faced in the engineering industry was the change in nature of product which became necessary for a great many works. In many cases the change was threefold, consisting of the addition of strange work, a change from general work to repetition work, and, lastly, a considerable change in size. Small wonder, then, that many old systems and methods which had worked reasonably well before then broke down completely and the need for new and different ones became very marked.

Under these new conditions of a keen search for methods suited to new needs it was only natural that a great deal of attention should be attracted to some of the newest methods making very wide and sometimes extravagant claims and rallying generally under the ægis of the movement known as "Scientific Management." Whether the exact nature of Scientific Management was well understood by the majority of those who took it up or by those who practiced it is very doubtful. Indeed, during the war years and subsequently the meaning of Scientific Management has itself undergone a change, partly to include a wider sphere of activities and partly on account of the modification of methods found to be necessary to adapt a scheme originally American to the particular needs and sentiments of this country. The term "Scientific Management" was "preempted" by the Taylor group of engineering managers in America and was adopted by them instead of simply "the Taylor system," as theretofore, as they thought it expressed more adequately the ideals underlying Mr. Taylor's methods. The more ambitious title has, however, proved to be less specific than the original one, and in the majority of cases where so-called Scientific Management has been adopted, very little attention is paid to the really painstaking work recommended by the founder.

Installing New Systems.—The trouble of installing the new systems thoroughly and soundly at the time of greatest demand was fundamental. In the first place there was not a sufficient supply of well-trained men having practical experience enough to overcome difficulties in working, and, in the second place, even where such men were to be found, there was no time then to go cautiously and to make every step sure. The work had to be done at once and was rapidly increasing. If the best method could not be introduced rapidly then a worse one was better than none. The very rapidity with which the new systems were installed was itself a difficulty and did not enable workers familiar with older systems to be properly educated to the change before it took place or even to become accustomed to it before there was some further modification. Under these conditions the widest possible range of successes and failures prevailed. In some case where capable organizers were secured and conditions were fairly favorable excellent work was done which would have been impossible under the old regime. In other cases only a partial modification of existing methods was possible, while in the worst cases the old methods and the new ran side by side in expensive rivalry, as a staff was maintained for each!

Conditions after the armistice caused a very keen review of all war innovations and found many of them wanting. The nature of the war changes itself often implied an alteration or modification of system and threw a severe strain on the new organizations and methods which they were not capable of bearing. The results of the inquiries made by heads of companies showed for the most part that the new organizations and methods were not as efficient as the old ones used to be and were many times more expensive. Consequently they were in many cases completely dropped as being unsuitable to peace conditions and too expensive to maintain in the face of keen competition. That these charges might be true in one or two cases of very small works may be admitted, but to say that they were generally true would not be fair without more close scrutiny.

The Gross Test.—If we accept the gross test that many works have tried some form or other of Scientific Management and have subsequently given it up, we shall be led to the conclusion that in this country Scientific Management has failed. We may, however, apply another and fairer test namely, of those few firms who had begun to test Scientific Management before the war how many have abandoned the attempt? Very few must have done so, we ourselves have not heard of a single case. There must, then, be some good cause for retaining the system in these cases, and it cannot have the chief drawbacks named. The reason why it failed is not that the system was intrinsically good or bad, but that under such conditions any system would have failed. The large influx of war workers meant that there were at any given time very few people who really had a grasp of the works system which concerned them, and still fewer were familiar with the systems of the works as a whole. Under these conditions flexibility was not to be expected, for in order to be flexible a system must be understood, not merely mechanically obeyed, by all those concerned with it. This can only be done in time. In the majority of cases it takes a long time; with a rapidly fluctuating staff it can hardly be done at all.

In the matter of expense too, good results could not be expected, for in all departments it was necessary to hire inefficient labor and to have a manager of labor, to provide for withdrawals of employes due to military requirements and to leaving to obtain promotion or higher wages elsewhere. Added to this was the difficulty of teaching workers raw to their job, which meant that in some cases the only practicable solution was to arrange for "one man one job," even if it did not quite occupy the whole of his time. Thus the charge levelled against Scientific Management on the ground of its expense must not be taken too seriously. If it is to be proved expensive it must be on the basis of efficient normal management and not on any temporary trails.

Future of Scientific Management.—To obtain an adequate idea of the future of Scientific Management we must examine a little more deeply into its essential nature. It is a movement which has had a sudden and tremendous vogue. Now it is under some measure of disapproval. Will it fade gradually away with other recollections of an exceptional period or will its basic nature guarantee its life and growth in this country?

The indications are that it will steadily regain favor. Its aim of substituting science and knowledge for rule of thumb methods in management is in accordance with the spirit of advanced industrialists, and there is no need to hamper the system here with the crude Americanisms which often accompanied it in the rush period, but which are not an essential part of it. Indeed, there is already formed what one might almost term an Anglicized version suited to home requirements and capable of giving good results on patient and intelligent application.

Taylor's own words, written in 1903, after 26 years of experience in installing his system, should strike home now to many of those who have been disappointed in Scientific Management. He said: "Probably a majority of the attempts that are made to radically change the organization of manufacturing companies result in a loss of money to the company, failure to bring about the change sought for and a return to practically the original organization. The reason for this is that there are but few employers who look upon management as an art, and that they got at a difficult task without either having understood or appreciated the time required for organization or its cost, the troubles to be met with, or the obstacles to be overcome, and without having studied the means to be employed in doing so.

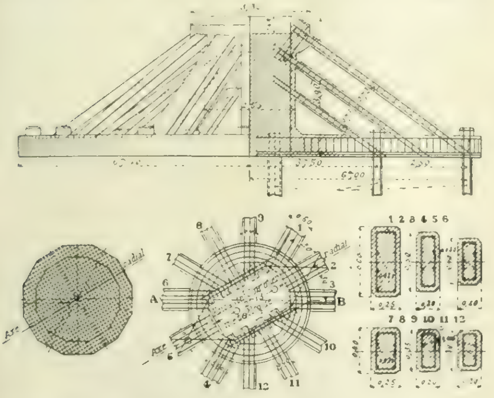
"Before starting to make any changes in the organization of a company the following matters should be carefully considered: (1) The importance of choosing the general type of management best suited to the particular case. (2) That in all cases money must be spent and in many cases a great deal of money, before the changes are completed which result in lowering cost. (3) That it takes time to reach any result worth aiming at. (4) The importance of making changes in their proper order, and that unless the right steps are taken, and taken in their proper sequence, there is great danger from deterioration in the quality of the output and from serious troubles with the workmen, often resulting in strikes."

Difficulties of War Period.—It will thus be seen that the difficulties of the war period were precisely similar to ones always present, but on an extended scale and subject to the special considerations we have mentioned. These failures are and always have been, exceedingly unfortunate for the future of genuine Scientific Management, especially when they result from some form of [illegible]. They have, however, never entirely checked the growth of the system, which, it is safe to say, will continue at first slowly and later more rapidly as its good points are proved to those who have used it rationally, by long and meticulous service. To formulate a code of scientific data in connection with management and industry is a work well worthy of prolonged attention: to subserve "the common interests of employers, workmen and society at large through the elimination of avoidable wastes, the general improvement of the processes and methods of production, and the just and scientific distribution of the product" is the first of the founder's claims of Scientific Management. These are ideals of permanent worth, independent of political faction and towards which industry will ultimately tend either by conscious or unconscious direction. Scientific Management has failed as a "philosopher's stone" to turn base systems into noble. It has even failed to keep its distinctive title entirely to itself, but for those who have used it carefully over a range of years it has generally been both successful and profitable.

Concrete Raft Foundations for Radio Station

From Le Génié Civil, Paris.

The foundation of the Lafayette radio-telegraph station at Croix d'Hins, near Bordeaux, were designed for a soil whose characteristics were almost unknown, and consisting largely of dune sand, and for resisting wind pressure which had to be assumed rather than determined, so that the engineers were faced with the very awkward problem of providing foundations to support an unknown load on a soil of unknown supporting power. Tests showed that the ground would carry a load of 2,700-4,000 lb. per square foot.



Sectional Elevation, Plan of Base Grill, Plan of Upper Part and Section of the Angle Pieces Forming Concrete Part of Structure.

Test piles 13 ft. in length were driven into the ground and showed that the latter had a greater carrying power than might be supposed, though they did not furnish any very precise information. Moreover, the ground was often boggy, so that a light superficial foundation was selected.

A consideration of the forces involved showed that the critical position is attained when the neutral axis is tangential to the perimeter of the base; such a condition is comparable to that in a metal prism subjected to a force which limits the attainable elasticity. There is no danger of ruptures, but the greatest care is necessary, and the usual rule for such cases limits the forces to half the limit of elasticity.

The details of the concrete raft with overlying base are shown in the accompanying illustrations.

Tubular Reinforcement of Concrete.—According to Le Constructeur de Ciment Armé of Paris, a factory recently erected at Lille has a reinforcement of small pipes or tubes up to 6 in. diameter and ⅛ in. thickness, strengthened where necessary by spiral wires ½ in. diameter. After the completion of the reinforcement or skeleton, it was completely embedded in concrete mortar.

Adsorption in Sand Filters

By JOHN DON

From the 1921 Proceedings of the Institution of Water Engineers

The present investigation was begun several years ago and at first had reference to permutit, a substance which is extensively used for the purpose of softening hard waters. The facility with which permutit removes compounds of calcium and magnesium from water is to be ascribed for the most part to the chemical interchange of soda on the one side and lime and magnesia on the other, but adsorption also plays its part in bringing the substances dissolved in the water within the range at which chemical action may assert itself. Permutit also removes ammonia from water and can be most usefully employed in removing the last traces of ammonia from ordinary distilled water.

Another filtering material which is supplied by a well-known firm is called polarite. This has as its chief property (so far at least as the present research is concerned) the well-defined power of removing iron in solution or in colloidal suspension in water. Here, also, the action is largely a chemical one, while adsorption again intervenes to enable the oxygen occluded in the polarite to engage successfully with the iron and so render it insoluble or coagulable. An account of the author's work on permutit and polarite will be found in the "Kolloid Zeitschrift," Vol. XV., 1914.

Recently extensive investigations have been made with ordinary sand, crushed quartz and felspar, in order to find out the law of adsorption by these substances in regard to ammonia, both ordinary and organic. In general, the experiments have been under laboratory conditions because it was necessary to exclude organisms that could "film" the filter.

Removal of Ammonia by Sand Filters.—Filtration through sand, as is well known, not only removes suspended matters and organisms, but also produces a very marked alteration in the amount of dissolved material.

We have sufficient evidence in regard to this from the reports published at water purification works. Among these may be mentioned the Metropolitan Water Board of London, the Waterleidingen of Amsterdam, and other installations on the Continent and in America and Great Britain. The chemical analysis of the service water before and after filtration shows a large reduction in the amount of ammonia due to the water percolating through the bed of sand. At London the reduction is frequently as much as 90 per cent. The average quantity of ammonia in Thames filtered water is about 0.002 parts per million, while that in the water which is led to the filters is not less on the average than 0.04 per million. To take a particular year (1907-8) it is noticeable that the value 0.002 varies but slightly from month to month (0.004 to 0.001), while on the other hand the quantity in the raw water is extremely variable (0.10 to 0.008), from which it will be seen that the sand filter is capable of dealing as efficiently with comparatively large as with small amounts of ammonia.

At Amsterdam the filters reduce the amount of ammonia by at least 90 per cent on the average. In the year 1919 the raw water contained 0.49 parts of ammonia per million, while the filtrate was practically free from it. A maximum content of the large figure of 0.98 per million was reduced to 0.02—i. e., by 98 per cent. With respect to albumenoid ammonia the decrease at Amsterdam on filtration is from 0.34 parts per million to 0.15 (Vecht water 1919), a fall of 55 per cent, and at London (Thames water) from 0.16 to 0.06, a decrease of 62 per cent. At other waterworks in Britain there is a considerable reduction in the amount of albumenoid ammonia in consequence of filtration.

Causes for Decrease of Ammonia and Organic Matters in Sand Beds.—The causes which have been assigned for the decrease of ammonia and organic matters in the sand bed may briefly be considered under three heads:

1. Adsorption by algae and micro-organisms (plankton) in the surface film of the filter.
2. Decomposition by bacteria with nitrates and nitrites as end products.
3. Adsorption by the sand particles and their watery envelopes.

With regard to the first of these there is little doubt that the blue and green algae and diatoms make use of the albumenoid matter and probably also of salts of ammonia, for it has often been remarked that they flourish well in water con-tion of many impurities. The annual reports of the Metropolitan Water Board show that ammonia is reduced under storage by 50 per cent at least on the yearly average, and this average is exceeded in the spring and summer months when vegetable forms are flourishing and plankton abounds.

Considering next the disappearance of a considerable fraction of albuminoid ammonia in the filter it may be said that this is the natural food of many species of bacteria, among which may be mentioned micrococci, bacillus termo, and proteus. These microorganisms disintegrate organic matter into various simpler bodies as fatty acids, tyrosin, leucin, water, etc. Nitrifying bacteria, without doubt, take part in the work of the sand filter, for at several waterworks an increase has been observed in the oxidized nitrogen in the filtrate. Nitrification is most noticeable in non-submerged filters which are occasionally employed to purify drinking water as at Bedford and Chateaudun, and in general for the treatment of sewage. The action of non-submerged filters is fully discussed in Prof. Dunbar's "Principles of Sewage Treatment." He attaches the greatest importance to the adsorption of impurities by the surface film surrounding the particles of sand or other material composing the filter bed.

A circumstance which supports Prof. Dunbar's view is that the time required for the purification of polluted liquids, as, for example, sewage effluents, is extremely brief. Ordinary sewage is rendered non-putrescible in ten minutes by passing through a coke filter bed 1 metre deep. The time is too short for bacteria to bring about this change, and one must conclude that the putrescible matters have been adsorbed by the components of the filter. Here the film surrounding the particles is probably more or less slimy and therefore better adapted to adsorb impurities.

But there is evidence that a considerable amount of purification may be obtained without the slimy skin which is characteristic of mature filters that have been in operation for a time and have "ripened," as the saying is. At Amsterdam, satisfactory purification is observed before the filters have had time to ripen, and at different places where the filters are roofed in and light excluded in order to prevent the growth of algae good results are recorded (see "Modern Methods of Water Purification," Don and Chisholm, 2nd edition, pp. 61, 84).

Experiments Under Laboratory Conditions.—In order to find out how far the granules of sand with their watery envelopes are able to assist in purifying water from dissolved materials a series of experiments were made. It appears that absorption of ammonia and its salts does certainly take place, and that organic matter is in general reduced.

Three filters were prepared by filling glass tubes of 1-in. bore and 66 in. long to a depth of 32 in. with fine sand or crushed quartz. The sand was of fairly uniform grade and of the fineness usually employed. It rested on 2 in. or 3 in. of coarser material and the lower ends of the tubes were drawn out and provided with screw clips to regulate the rate of flow. Before a series of experiments the sand was thoroughly washed with tap water, then with boiling water, and finally was strongly heated for some time. The rate of filtration per hour in Filter No. 1 was approximately 20 in., in No. 2 12 in., and in No. 3, 2 in.

In the first set of tests the "raw" water was represented by distilled water containing so much of a common salt of ammonia as represented 1 part of ammonia per million.

Samples were taken one after the other when a column of water 20 in. deep had passed through. It was found that the adsorption at the beginning was almost perfect, over 80 per cent of the ammonia being removed from the first five samples, but after that there was a gradual falling off. When a column of 200 in. had passed, only about 50 per cent of the ammonia was retained, and when 400 in. had filtered the adsorption was practically nil. From the whole of the water passing in this way 58 per cent of the total ammonia had been retained by the sand. 400 in. is practically 1,000 cm., and 1 part per million is 1 mg. per litre (1,000 c.cm.). In a column of water 1 sq. cm. in section and 1,000 cm. deep, there would be present in the unfiltered solution 1 mg. of ammonia. Therefore, as the sand in the experimental filter which was 80 cm. deep (32 in.) absorbed 58 per cent of 1 mg. of ammonia, 1 cu. meter of sand could absorb over 7 grs. of ammonia from a solution of the concentration of 1 part per million. Under the same conditions 1 cu. yd. of sand would absorb about one-fifth of an ounce of ammonia.

Table 1 shows the percentage of reduction ammonia in each sample and also the percentage of the total adsorption possible at each step (column 4).

TABLE I.—RESULTS FOR FILTER NO. 1

(1) No. of sample	(2) Column of water filtered. Inches	(3) Reduction of ammonia. Percentage	(4) Total adsorption. Percentage
1	20	94	8
2	40	94	16
3	60	[illegible]	[illegible]
4	80	90	[illegible]
5	100	[illegible]	[illegible]
6	120	[illegible]	[illegible]
7	140	[illegible]	[illegible]
8	160	[illegible]	[illegible]
9	180	[illegible]	[illegible]
10	200	[illegible]	[illegible]
11	220	[illegible]	[illegible]
12	240	[illegible]	[illegible]
13	260	[illegible]	81.1
14	280	[illegible]	[illegible]
15	300	[illegible]	[illegible]
16	320	[illegible]	[illegible]
17	340	[illegible]	[illegible]
18	360	[illegible]	[illegible]
19	380	[illegible]	[illegible]
20	400	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	

The sand was removed from the tube at the completion of a set of tests before commencing another, and it was found necessary to wash with boiling water and afterwards to heat over a Bunsen flame for some time in order to obtain a consistent sequence of results. Sand which has merely been washed in cold water has much less power of adsorption.

Filter No. 2.—Different and probably improved results were expected from this filter, but were not realized. The amount of ammonia adsorbed was seen to depend chiefly on the quantity of water that had passed through the sand. This conclusion was confirmed by tests made with the very slow filter No. 3, in which the rate of percolation was 2 in. per hour. The results of the first six tests are shown below:

(1) No. of sample	(2) Column of water filtered. Inches	Reduction of ammonia. Percentage
1..	20	95
2..	40	95
3..	60	92
4...	80	90
5..	100	90
6..	120	85

Although the rate of percolation was in this case one-tenth that with Filter No. 1, the degree of purification was very much the same, and this would confirm the statement made by Prof. Dunbar that adsorption proceeds very rapidly.

A freshly-cleaned sand filter of the ordinary type would retain a certain percentage of the ammonia present in the raw water during the first two or three days of its action as a result of adsorption by the granules of sand.

From various waterworks, samples of raw water and of the first day's effluent have been obtained and analyzed. It appears that the amount of ammonia in the latter is reduced by the varying percentages ranging from 50 to 80. Samples taken from a rapid mechanical filter immediately after washing also showed large reductions.

We know that sand filters working out of doors may continue for many days to reduce the content of ammonia by 80 per cent or even more. To the film of vegetable and animal growths which is formed on the surface of the sand must be attributed the power of maintaining the adsorption of ammonia. To test this, a filter which had almost ceased to remove ammonia was "seeded" with growths from an open sand filter and allowed to rest for a few days in a moist condition. The first ten samples thereafter taken showed an average reduction of 92 per cent.

Adsorption of Albumenoid Ammonia Under Laboratory Conditions. In carrying out experiments under this heading it must be remembered that under storage, as Sir A. Houston has shown, the amount of organic matter diminishes, so that it is necessary to check the condition of the raw water from day to day before beginning to filter.

After various trials it was found best to prepare a solution of urea in distilled water (free from ammonia) of such strength that it would yield on decomposition 2 parts of ammonia per million on decomposition.

It became evident that the rate of filtration was of comparatively little importance, and accordingly the quick filter No. 1 was used in this set of experiments. The results are shown in Table II.

TABLE II

(1) No. of sample.	(2) Column of water passed Inches.	(3) Reduction of org. ammonia. Percentage.	(4) Total adsorption Percentage.
1	8	[illegible]	[illegible]
2	16	[illegible]	[illegible]
3	24	[illegible]	1
4	32	[illegible]	[illegible]
5	40	[illegible]	[illegible]
6	48	[illegible]	[illegible]
7	56	[illegible]	[illegible]
8	64	[illegible]	[illegible]
9	72	30	[illegible]
10	80	22	[illegible]
11	88	16	[illegible]
12	96	10	[illegible]
13	104		

*Negligible.

It was generally noticed that the first runnings were less acted upon than those immediately following, and this is probably due to the fact that the granules of sand after being dried are not very readily wetted. It appears from the above that a sand filter 1 sq. cm. in section and 80 cm. deep can remove 36 per cent of organic ammonia from 240 cu. cm. of the test solution (240 cm. equals 96 in. approximately). In this way a cubic meter of sand would adsorb about 2 grs. of organic ammonia, and a cubic yard would take up nearly one seventeenth of an ounce of organic ammonia.

Referring again to Table I, a fifth column might be added to show the adsorptive power of the sand after each sample in succession has passed through. Assuming 100 as the initial figure, then after the first sample has been drawn the adsorptive power is reduced to 100-8—that is, 92, and after the second sample, 100-16—that is, 84, and so on. The amount of ammonia adsorbed should bear a relation to the adsorptive power of the filter and to the concentration of the solute. Owing to the rapid adsorption at the beginning, the concentration of ammonia in the filtering water is necessarily small, especially in the deeper layers of the sand, so that the amount of ammonia taken up is limited on that account.

As the adsorptive power of the sand diminishes the concentration of ammonia in the water percolating increases, and this, on the other hand, is favorable to increased adsorption. In the case of the particular filter here employed the fraction

$$\frac{\text{Amount adsorbed from each sample}}{\text{Adsorptive potency of the sand}}$$

increased gradually from an average of 0.07 in the first three samples to 0.124 in the next three, and to 0.144 in the following three, while the average for the remaining samples was 0.23.

Samples of raw and filtered water have been obtained from a number of public waterworks, and analysis shows that there is in general a fairly large reduction of the amount of organic ammonia in the first runnings of the filters after cleansing. This action increases and eventually attains a steady value which persists for some time. Towards the end of the run when the filter is becoming clogged the amount of organic ammonia in the effluent shows variations, in some cases increases, in others decreases were noted, but never more than 10 per cent from the average.

In conclusion, it appears from these experiments under laboratory conditions that a sand filter freshly prepared is capable of adsorbing fairly large amounts of ammonia and dissolved organic substances, and that this action takes place rapidly. Sand which has ceased to adsorb dissolved substances must be thoroughly washed, which is best done with boiling water, before commencing another set of experiments.

Tested by the approved methods, the surface tension of water containing one part of ammonia per million does not differ from that of pure water. With higher concentrations, as one per hundred thousand or one per ten thousand, there is hardly a measurable difference in the surface tension. Hence, to explain the retention of ammonia in the filter one cannot fall back on the thermodynamic law of W. Gibbs and Sir J. J. Thomson that, "if the surface tension diminishes with increasing concentration the surface film will contain more of the solute than the solution does." The film surrounding the particles does not enrich itself from the solute at the expense of the rest of the water passing. Now, the fact is, that the liquid within the filter is simply a moving film which embraces the sand granules and slowly glides downwards. The true seat of adsorption must be looked for in the particles of sand themselves whose wetted surface withdraws from the inner face of the watery film some portion of the dissolved substances. Hence, the necessity of thoroughly washing the sand after it has ceased to adsorb before repeating a set of tests.

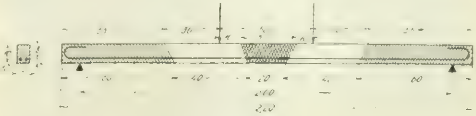
Exactly the same remarks apply to organic matters in solution so far as the present experiments show. The surface tension of water is not sensibly diminished by dissolving urea to the concentration used, nor even to much higher concentrations, and accordingly the sand itself is the seat of adsorption.

In comparing the effect of sand with that of polarite or permutit there is this difference to remark, that in the case of the two artificial purifiers the action is to a great extent a chemical interchange, and probably not much true adsorption occurs. With them it becomes rather an instance of the penetration of a substance into the interior of the compact granules where this effort is also aided by chemical affinity. There is no reason to suppose that anything of the kind occurs between sand and dissolved materials, the whole action is of the nature which we are familiar with in the case of soils whose properties have been so fully investigated by Van Bemmelen, Prof. Ehrenberg, and many others.

Concrete Testing on the Site

From Beton u. Eisen, Berlin.

One of the most serious objections to the customary methods of testing cement and concrete is the great length of time required. The result is that a concrete structure may be so far advanced that it is impracticable to pull it down when the results of the tests are received, whereas if the tests could be completed in a week there would be far less difficulty.



Test Beam.

Dr. Emperger has now shown that sufficiently reliable results can be obtained for all practical purposes by making a test beam of suitable dimensions, but instead of making the whole beam afresh for each test he now cuts out the center portion, leaving the greater part of the beam intact, and fills in the middle with the fresh concrete.

He suggests a beam of the dimensions shown in the illustration (in centimeters) only the portion being the vertical arrows (about 20 in.) being renewed, so that the material required for a test is only about 264 cu. in., though it is better to use more rather than less this amount. With care, accurate results can be obtained if only half this volume (the middle shaded portion of the illustration) is used.

The beam is tested in the ordinary manner by supporting it on two knife-edges and measuring the modulus of rupture when a load is applied at the middle by means of a third knife-edge.

The beam may be tested eight days after it has been remade.

Australian Railways Change of Gauge.—Again the stereotyped decision has been arrived at by the states premiers' conference that the adoption of a uniform railway gauge is essential to the development of the safety of the Commonwealth. The conference also accepted the recent commission's rcommendation of a 4 ft. 8½ in. gauge. Further it was decided that the Commonwealth shall prepare and circularize to the states a draft agreement to give effect to the recommendation of the commission. That steps shall be at once taken by the premiers of the states to consult their governments with regard to the said agreement and the financial obligations of the parties thereunder. The total cost of making the gauges uniform throughout Australia was estimated by the royal commission at £57,000,000. A modified scheme was proposed by Mr. L. E. Groom, minister for home and territories, to cost £21,000,000, spread over a period of seven years. The modified scheme proposes the conversion of the trunk line linking up the capitals of the five states.—The Commonwealth Engineer, Melbourne, Australia.

Refuse Disposal for London

From The Surveyor, London.

The conference of metropolitan borough councils convened by the Westminster City Council to inquire into the question of refuse disposal in the metropolis, has issued the final report of the committee which it appointed to investigate the best means of refuse disposal. The members of the committee included Messrs. E. J. Ames, M.Inst.C.E., borough engineer and surveyor of Bermondsey; Mr. A. F. Holden, Assoc.M.Inst.C.E., borough surveyor of Fulham; Mr. J. Patten Barber, M.Inst.C.E., borough engineer and surveyor of Islington, and Captain F. W. Cable, M.C., Assoc.M.Inst.C.E., city cleansing surveyor, Westminster.

Amount of Refuse Collected.—The average quantity of refuse collected each year in the Administrative County of London is, the committee point out, 1,217,148 tons and 299,304 cu. yd., say 1,500,000 tons. Taking the working days in a year at 300, the figure of 5,000 tons per day is obtained. In the work of collection and disposal 1,204 single-horse vans, 48 pair-horse vans, 61 motor lorries and 17 trailers are used, a total of 1,330 vehicles. The refuse collected is dealt with as follows: 670,000 tons of refuse, or 44.66 per cent, are taken away by barge to dumps; 250,000 tons, or 16.66 per cent, by rail dumps; 280,000 tons, or 18.66 per cent, are burnt in destructors, and 300,000 tons, or 20 per cent, are disposed of at local dumps, by sale, etc. From these figures it would appear that practically 80 per cent of London's house refuse is at present disposed of by dumping.

It is computed that the average cost of refuse disposal throughout London, exclusive of collection, is approximately $1.92 per ton. On that basis the annual cost would be £600,000, and the daily cost £2,000.

Composition of House Refuse.—The committee quotes from the Engineer's Year Book of 1913 the result of an examination of London house refuse, which they are given to understand is for all practical purposes still of the same consistency as it was when the examination was made, the only variation being in the percentage of any one of the constituents.

COMPOSITION OF LONDON REFUSE

Material	Amount in 100 lb. of refuse
Coal	.35
Coke	.15
Breeze and cinder	25.55
Ash	47.00
Dust and dirt	9.75
Paper, straw, fibrous material and vegetable matter	13.15
Rags	.40
Bones and offal	.37
Bottles	.48
Glass	.37
Crockery	1.72
Metals	.68
	99.97

"This refuse," the committee remark, "containing as it does vegetable and animal properties liable to decompose and putrefy, is in the mass offensive, and after a time dangerous to health. But it also contains other properties which, if the trouble be taken to separate them, have a considerable commercial value. Moreover, the table shows that the offensive and dangerous properties are a very small proportion of the whole. The first three items of the table, representing over 26 per cent of the whole, are fuel. In every 100 tons of refuse, therefore, there are 26 tons of fuel. Ash is 47 per cent, or nearly one-half, of the whole. This material is useful and saleable for agricultural purposes. Rags, bones, bottles, glass, crockery and metals can in normal times all be profitably disposed of."

Value of Refuse for Agricultural Purposes.—In the course of their investigations the committee had an interview with E. H. Sams, of the firm of E. H. Sams & Co., lime and manure specialists, of London and Uckfield, Sussex, who stated that in his opinion the whole of London's refuse could be sold to farmers if the tins, glass, crockery, ashes and cinders were first eliminated and the remainder crushed and then mixed with chalk. With discrimination in distribution Mr. Sams thought there could be secured an outlet for this material all the year round. For the disposal of the crushed and treated refuse he suggested a committee or a combination of councils employing one organization with an agricultural expert as the organizer. The organizer would obtain special railway rates and arrange distribution of the material. Mr. Sams was of opinion that by this means the whole of London's refuse could be disposed of continuously at a saving on present costs of 25 per cent for the first three years, and anything up to 100 per cent after that period. He considered it would be impossible to obtain such satisfactory results if each borough council endeavored to sell their own output, as obviously they would be competing in the same market, and in his judgment, the only method to ensure profitable results was by having one organization to sell the whole of the output of the metropolitan boroughs.

In setting out their conclusions the committee deal with five methods of disposal: (a) dumped on the land, or (b) in the sea; (c) burnt in destructors; (d) pulverized by machinery, or (e) screened and graded by machinery.

Dumping on the Land.—The system of dumping crude refuse on low lying land, in disused clay pits and in quarries, although at present the principal means of refuse disposal, will, we believe, be generally condemned for public health reasons if for no other. Disposal being almost entirely in the hands of contractors, very little regard is paid to the future use of the land or the amenities of adjoining owners. The process of consolidation is slow and in many respects insanitary. The only districts in which considerable tracts of low lying land suitable for dumping are situate are along the lower reaches of the river, and the time must come when they will have received their complement and cease to be available for the purpose. Such land is mostly in the hands of a few contractors, and municipalities are thus obliged to employ those contractors to take their refuse, sometimes, we are afraid, at exorbitant rates of charge.

"From the point of view of public health no word can be said in favor of dumping crude refuse. Nearly all rural authorities strongly object to land in their areas being used for this purpose (although they may adopt the same means of disposal), chiefly owing to the fact that at most dumps there is no organized method of covering over the top surface with suitable material, and no attempt is made to bring the land back into cultivation. Consequently there is a continual risk of nuisance being created by fermentation and the dump becomes a breeding ground for flies and rats.

"As regards expense, the cost per ton is very high, and the fact that refuse has commercial possibilities, which are already being realized to some extent, emphasizes the point that, whereas all expense in dumping refuse is dead expense year by year without one farthing of recoupment, every ton of refuse salved means a clear profit of from 5s. to 10s.

Dumping in the Sea.—This proposition has been put to us, and while, if it could be assured that there would be no return of the material with the tides, the system would have the merit of being sanitary, the cost of the necessary transport to riverside wharves and sea hoppers removes it, we think, from the sphere of practicability. There is also the possibility of long delays owing to unfavorable weather conditions.

""**Burning in Destructors.**—Refuse destructors have been in existence many years, and they have the undoubted advantage of disposing of the dangerous elements which develop in refuse when left to ferment and decompose. . . Heat is generated (according to the nature of the refuse and the type of destructor) and there are possibilities of saving coal by using the heat for steam raising. The clinker resulting from the burning of the refuse can be used after crushing in a number of ways, and as a base for various manufactured articles—e. g., paving flags, building slabs, concrete, road material, etc.

"Having shortly touched on the advantages of destructors, we venture to question whether destruction by burning would be found to be the most suitable or economical method of disposal for adoption throughout London to the exclusion of others.

"Even with forced draft and high chimney the fumes given off make it necessary for the site of a destructor to be carefully selected in an open position as far as possible away from houses. The success or failure of a destructor may be measured by the rapidity with which it consumes the refuse, and the proportion of clinker remaining after the burning. The large quantity of residual clinker has in the past been one of the chief arguments against the destructor. We believe the most favorable results in this respect show from 20 to 33 per cent of clinker per ton of refuse burned. It will thus be seen that the effect of burning in favorable circumstances is to substitute for one ton of refuse 6⅔ cwts. of clinker. Assuming for a moment that the whole of London's house refuse [illegible] that the clinker amounts only to 33⅓ per cent, and taking house refuse at 75 per cent (average) of the total of London's refuse, the quantity of clinker produced would be 366,666 tons per annum, or 1,222 tons per day. To enable this tonnage of house refuse to be dealt with by means of destructors, a capital expenditure of not less than £1,250,000 would be involved. This spread over 20 years at 6 per cent would mean an overhead charge of approximately 2s. per ton, so that taking into consideration working costs and removal of clinker, the total net cost of disposal by destructor would be not less than 8s. per ton under the most favorable circumstances. We think, however, that it is doubtful whether so small a residuum as one-third would be found to be the average of all the destructors in use, and would point out that the discontinuance of destructors owing to unsatisfactory, insanitary and uneconomical working is not unknown. . . . It is our opinion that the part to be played by the destructor in the future will be, not the burning of all refuse, but that part of which no further use can be made.

"**Pulverizing or Crushing.**—. . . One of the most valuable attributes of the pulverizer is that it greatly reduces the bulk of the refuse, and brings it to a uniform consistency after the extraction of metals and large elements. The Southwark Borough Council have been successful by means of their plant in keeping the cost of refuse disposal at a very low figure. Although up to the present year half of the total output of Southwark's house refuse had to be dealt with in a crude state by rail to dump, the help afforded by converting the remainder into a saleable commodity and by selling road sweepings, etc., has been the means of reducing an already low gross cost of 5s. 11d. per ton (against the metropolitan average of 8s.) by 40.84 per cent to 3s. 6d. per ton.

"**Salvage of Usable Constituents of Refuse**—. . . Although unsorted refuse is objectionable and would soon become dangerous to health, the fact remains that practically every one of its component parts separated from the remainder is a usable and useful commodity. The development of machines for accomplishing this work of separation has proceeded rapidly of late. That installed by the St. Marylebone Borough Council is practically the only example in London up to the present, but a number have been set up in the provinces and the Council of the City of Westminster are installing an experimental plant of a similar description (though differing in detail) to deal with a part of the city refuse. . . .

"The degree of success achieved in selling the various materials salved from the refuse depends in some measure on the form in which they are put up after separation. Hydraulic presses are an important adjunct to a salvage plant. By means of these contrivances such things as paper, rags and tins are compressed into bales of uniform size. They are more conveniently handled and transported, and fetch better prices in such form.

"The prices obtained vary according to the state of trade generally. Too much stress should not, however, be laid on the question of profit. If the proceeds are sufficient to cause an appreciable reduction in the net cost of refuse disposal the system would be justified.

"Salvage plants are still in their infancy, and we do not give any details as to capital costs owing to the variations possible according to the extent to which it is desired to sort the refuse and the manner in which the residue after sorting is disposed of. The cost of erecting on a provided site a plant capable of dealing with from 20,000 to 40,000 tons of refuse per annum may be estimated at about £15,000. Allowing for repayment of capital and interest and for running expenses and taking only a moderate estimated return on sales, a very considerable saving can be shown over present-day costs of barging or railing to dump.

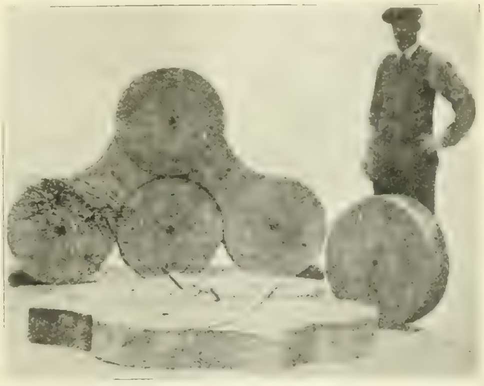
"It is not suggested that destructors and other systems of refuse disposal showing some return on working should be scrapped, but it is suggested that in some cases (and they are the majority in London) where refuse is barged or railed to dump in its crude state, the councils concerned would be well advised to give the closest and most serious consideration to the possibilities of salvage."

The Best Means of Refuse Disposal.—Finally the committee express the belief that the great bulk of the refuse can be converted into marketable commodities and can be sold in relief of the rates. To put an extreme case from the economic point of view only: If the cost of erecting and working a salvage plant were less than the cost of barging or railing to dump, even if no purchasers of the salved refuse could be found and the material had to be given away, salvage would still be justified. Screening and crushing greatly reduce bulk and render the material largely innocuous, thus meeting the objection to dumping from the public health standpoint. The committee's estimate of the present average cost of disposal throughout London is, as previously stated, 8s. per ton, and they contend that by every 1s. per ton that figure is reduced, the ratepayers of London will benefit to the extent of £75,000.

Pre-Cast Concrete Pavement

From The Surveyor, London

A patented system of pre-cast construction, introduced by Spagnoletti & Grumpan, 8 Victoria St., S. W. 1 London, is illustrated. Under this system a road is formed of pre-cast, well-seasoned concrete blocks 2 ft. in diameter, with diamond-shaped blocks filling in these spaces formed by laying four circular blocks tangentially to each other. For the purpose of keying the blocks together steel dowel pins are passed from the surface of the blocks into diagonally extending holes placed 3 in. from the periphery of the blocks. Grout or a bituminous substance is worked into the holes, fixing the pins and locking the blocks. Pitch, mexphalte, or other bituminous substance is worked in between the interstices.


Units of Pre-Cast Concrete Pavement.

French Tidal Power Scheme.—The construction of a tidal power-station on the estuary of the Diouris, a small stream which enters the sea at Aber Vrac'h, in Finistere, about 15 miles north of Brest, is proposed by the Societe Financiere pour l'Industrie, according to Concrete and Constructional Engineering, London. The plans involve the construction of three reinforced concrete caissons in the middle of the estuary, together 70 meters wide. The largest, in the center, will contain the turbines; its bottom will be 13.20 meters below standard water-level, and its top 12.80 meters above, or 4.30 meters higher than the level of spring tides. Flanking this caisson on each side will be two smaller ones, to contain sluices. The caissons will be connected to each shore by masonry walls, giving the barrage a total width of about 150 meters. A lock will permit the passage of ships. The turbines installed in the central caisson will be of the Escher Wyss type, designed to generate while running in either direction, to block the passage completely or act as sluices, and to operate as pumps. On a rising tide the water will flow from the sea into the inner basin through the turbines, and when the level of the water is the same on both sides of the barrage, the turbines will be stopped, until with the ebbing tide the level of the sea falls sufficiently to enable them to be operated again with the water from the basin. In addition there will be a second reservoir, constructed on the Diouris just above the limit of the tidal range, to feed a second generating station. It is estimated that the tidal turbines will supply about 7,900,000 kw. hours, of which the industrial load will absorb 5,500,000 kw. hours. The surplus will be employed in pumping water into the upper reservoir, the station in connection with which will furnish 3,900,000 kw. hours.

Gas Protective Measures in Sewer Inspection

By H. C. WHITEHEAD

Chief Assistant Engineer, Birmingham, Tame and Rea District Board

From The Surveyor, London

It is only too often realized by [illegible] reports that [illegible] sewers and sewage works are not always adequate, and it is the author's hope that this paper will have the effect of calling attention to a growing need for revision in terms of our safety regulations for the protection of men inspecting or working in public sewers.

In industrial areas the universal use of petrol and other kindred fuels has placed the once common practice of testing a manhole before entry with a naked light on the same footing as the undesirable practice of locating gas leaks with a lighted candle.

The principal dangers which are present in all confined spaces where sewage decomposes are: (1) Poisoning by sulphuretted hydrogen; (2) suffocation through lack of oxygen; (3) ignition of inflammable gases.

Poisoning. The author regards the first danger as the most important for the following reasons: (a) It is fatal in quite small quantities, (b) the ill-effects from non-fatal small doses are cumulative, (c) a safety lamp will burn in a fatal mixture of this gas and atmospheric air, although its presence is usually accompanied by a reduction in the quantity of oxygen present.

Fortunately the presence of sulphuretted hydrogen is readily detected by means of lead acetate papers. These papers are a commercial commodity, and may be purchased in small book form of any wholesale chemist, or may be made by soaking slips of white blotting paper in a solution of lead acetate.

The test for the presence of sulphuretted hydrogen simply consists in lowering one of these moistened lead papers into the manhole or underground chamber it is proposed to enter. If the lead-paper darkens within a minute sulphuretted hydrogen is present in fatal or dangerous quantities.

The primary cause of this danger is lack of ventilation. The oxygen normally present in the atmosphere above the sewage is reduced by absorption as the result of bio-chemical changes in the sewage and is further reduced by dilution with the gases given off during this change.

In manufacturing areas an additional dilution is often caused by the discharge of trade wastes containing ammonia, acid vapors or steam.

If a lighted safety lamp will not burn for two minutes when lowered into a manhole, it should be assumed that sufficient oxygen does not exist to support respiration.

Ignition of Inflammable gases.—In addition to marsh gas (methane) and hydrogen, which are evolved during bio-chemical changes in sewage, it is becoming increasingly frequent to find petrol, benzol, mineral naphtha and other inflammable vapors present in sewers.

In view of the commercial value of these spirits it is probable that their presence may be more due to accidental than wilful discharge, but the fact remains that here is a growing danger which should be checked and guarded against at every possible opportunity.

The presence of inflammable gases may be detected by means of a "detector" type of safety-lamp, as used in coal mines. These lamps are fitted with thin wires forming a ladder above the lamp flame, and the test consists in observing if any of the wires become red hot and thus indicating that gas of this nature is present. A highly explosive mixture is formed when marsh gas is present in the proportion of 1 volume of gas to 7 volumes of air.

Sequence of Tests.—It is, of course, essential that these tests should be carried out in their correct sequence, and it may be helpful to state briefly here the routine to be observed before entering any manhole.

1. Test for sulphuretted hydrogen with lead-paper. If paper darkens within a minute danger from poisoning is indicated.

2. If No. 1 test gives no darkening, lower a lighted safety-lamp into the manhole for two minutes, and if still alight it is safe for a man to go down and carry out test No. 3.

3. Test for inflammable gas with "detector" safety-lamp. (This type of lamp may also be used for No. 2 test.)

Smoking and the use of naked lights should be absolutely forbidden, even after a negative result from the third test.

The foregoing dangers are to be met with in all non-manufacturing towns, and with additional danger from trades wastes in manufacturing areas.

Trades Wastes. Gaseous trades wastes include steam, ammonia, petrol and gases evolved in the various processes of manufacturing coal gas. With the exception of carbon monoxide, which is extremely dangerous as a poison, tests Nos. 2 and 3 afford a considerable amount of protection from the usual gases evolved from trades wastes. Fortunately CO is rarely met with in sewers, but the author would be glad to learn of a simple reactionary test which would afford the same amount of protection as that given against sulphuretted hydrogen by test No. 1.

General Precautions.—The author does not propose to attempt to draft a set of safety regulations for general use, as it is obvious that local conditions are a governing factor in the framing of them, but it may be helpful to mention a few necessary general precautions. In the first place, a survey for the location of danger areas should be carried out.

This is not a formidable operation, even in a large town and may be done by carrying out tests Nos. 1, 2 and 3 in selected areas.

It will generally be found that junctions of high and low level sewers, manholes containing "black drops," storage sewers and tanks in pumping areas are localities which should be selected for testing purposes.

Where it is not practicable to remove the danger by improved ventilation or constructional alteration, a means of marking dangerous manholes should be adopted. This may take the form of a metal disc fixed to the underside of the manhole frame and visible when the cover is removed.

Opportunities should be made to explain safety regulations to the man actually engaged on sewer work. This can be done best by actual demonstration of the routine to be followed. Safety-lamps, lead-papers and safety-lines should be in the personal charge of each sewer ganger or charge hand, and should be checked and inspected at frequent intervals.

Covered storage tanks, pump-wells and large underground chambers should be provided with at least two access openings, the covers of which should be removed half an hour before cleansing or repair work commences. The necessity of having easy means of access cannot be too strongly urged. Far too many manholes, even of modern design, are only usable by a small-size acrobat.

It should be borne in mind that the disturbance of sludge when cleansing a tank or pump-well frequently releases quantities of gas (principally marsh gas), and it is advisable to watch for indications of this gas in the "detector" safety-lamp.

The movement of gases from other parts of the sewer to a manhole which has been tested and found free of gas is a very real danger, which may be partially guarded against by opening manhole covers on each side of the one in which it is desired to work. This precaution should invariably be taken if it is intended to spend more than a few minutes in a manhole.

The causes of gas movement are: Fluctuation in sewage flow, diffusion, barometric and temperature changes, propulsion of suction from ventilators, temporary removal of manhole covers, and the influence of surface friction from flowing sewage.

It is usual nowadays to provide "first-aid" outfits on sewage works and at highways depots. A valuable addition to these outfits is an oxygen cylinder fitted with respiration mouthpiece and rubber-tubing. The cylinder should be provided with a pressure-gauge in order that leakages may be noticed and checked.

In conclusion, the author would urge that the two most valuable safeguards are the design of sewers which are self-cleansing under normal flow, free from "back-drops," high-level junctions, "tumbling-bays," catch-pits, and such-like stink generating devices; and, secondly, the regular inspection of works discharging trades wastes into sewers with a view to enforcing the provision of suitable arrangements for continuous discharge and dilution of liquid wastes, and the prevention of gaseous discharges.

The Stresses in Rigid Portal Frames

By EWART S. ANDREWS

From the Engineering [illegible]

With the development of reinforced concrete construction the question of stresses in rigid frames becomes of great importance to designers, particularly in view of the fact that experimental researches have shown that considerable bending moments do occur in the columns as foreshadowed by the theoretical treatment.

Most designers have now become familiar with the Theorem of Three Moments for dealing with continuous beams, but find some difficulty in following the usual method of investigating the bending moments in rigid frames.

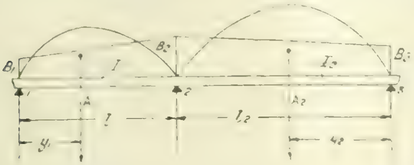


Fig. 1.

We propose to show that the simplest form of rigid frame, which is known as the rigid portal frame or "goal post" structure, can be investigated by an application of the Theorem of Three Moments, the three members of the structure being imagined as opened out into a straight line forming a continuous beam of three spans.

For this purpose we have first to express the Theorem of Three Moments in a form which allows for different moments of inertia of the separate spans.

Referring to Fig. 1, the Theorem in its general form gives the following relation between the support bending-moments, B_1, B_2 and B_3 for three successive supports 1, 2 and 3 of a continuous beam, viz.:

$$\frac{B_1 l_1}{I_1} + 2B_2\left(\frac{l_1}{I_1} + \frac{l_2}{I_2}\right) + \frac{B_3 l_2}{I_2} = 6\left(\frac{A_1 y_1}{I_1 l_1} + \frac{A_2 y_2}{I_2 l_2}\right) \quad . \; . \; . \; . \; (1)$$

In this equation:

l_1, l_2 are the lengths of the successive spans;

I_1, I_2 are the moments of inertia of the beam sections of the successive spans;

A_1, A_2 are the areas of the "Free bending-moment" diagrams on the successive spans;

y_1, y_2 are the distances of the centroids of these diagrams from the verticals through the end supports.

Frame with Uniform Load; Columns Hinged.—(Fig. 2). Let I_b be the moment of inertia of the beam section and I_c that of the column section; and let l be the length of the beam and h the height of the column.

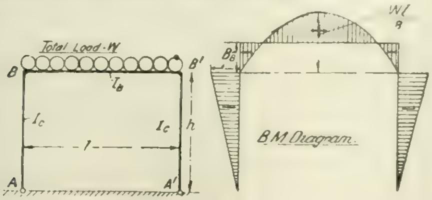


Fig. 2.

Then the frame is equivalent to a continuous beam of three spans, the center one of which is loaded with a uniformly distributed load W.

The extreme ends A, A^1 are hinged so that $B_a = B_a{}^1 = 0$. Further, it is clear from symmetry that $B_b = B_b{}^1$.

Now apply the Theorem of Three Moments to the spans of A B, B B^1, remembering that because there is no load on A B the value of A_1 will be zero, and that A_2 will be equal to the area of a parabola of height $\frac{Wl}{8}$ and base l, i.e. $= \frac{2Wl}{3 \cdot 8} \cdot l = \frac{Wl^2}{12}$, y_2 being equal to $\frac{l}{2}$.

We then obtain the following result:

$$0 + 2B_b\left(\frac{h}{I_c} + \frac{l}{I_b}\right) + \frac{B_b l}{I_b} = 6\left(0 + \frac{Wl^2}{12} \cdot \frac{l}{2 \cdot l I_b}\right)$$

$$\text{i.e. } B_b\left(\frac{3l}{I_b} + \frac{2h}{I_c}\right) = \frac{Wl^2}{4I_b}$$

$$\text{i.e. } B_b \frac{l}{I_b}\left(3 + \frac{2h}{l} \cdot \frac{I_b}{I_c}\right) = \frac{Wl}{4} \cdot \frac{l}{I_b}$$

$$\text{i.e. } B_b\left(3 + \frac{2h}{l} \cdot \frac{I_b}{I_c}\right) = \frac{Wl}{4}$$

Now $\frac{h}{I_c} \cdot \frac{I_b}{l} = \frac{I_b}{l} \div \frac{I_c}{h}$ and is commonly called the stiffness co-efficient, and given the symbol s we therefore have:

$$B_b(3 + 2s) = \frac{Wl}{4}$$

$$\text{i.e. } B_b = \frac{Wl}{4(2s+3)} \quad . \; . \; . \; . \; . \; (2)$$

This agrees with the result obtained by considering the problem from different standpoints.

The resulting B.M. diagram upon the structure then comes as shown on Fig. 2.

Frame with Uniform Load; Columns Fixed.—(Fig. 3.)—Now suppose that the columns are fixed at their ends. The procedure with continuous beams with fixed ends is to imagine to exist beyond the fixed end an additional span which is a mirror reflection of the end span, and to apply the Theorem of Three Moments to the end span and this imaginary additional span.

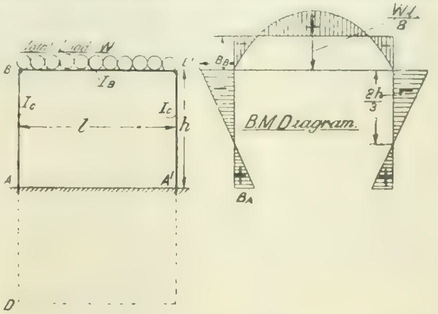


Fig. 3.

In our case this imaginary span is AD, and B_d must be equal to B_b.

Now apply the Theorem to the spans DA, AB, remembering that there is no load on AB; we then have:

$$\frac{B_d . h}{I_c} + 2B_a\left(\frac{h}{I_c} + \frac{h}{I_c}\right) + \frac{B_b . h}{I_c} = 0 + 0$$

$$\text{i.e. } B_b + 4B_a + B_b = 0$$

$$\text{i.e. } 4B_a = -2B_b$$

$$\text{or } B_a = -\frac{B_b}{2} \quad . \; . \; . \quad . \; . \; . \; . \; (3)$$

Next apply the Theorem to spans AB, BB^1; this gives:

$$\frac{B_a . h}{I_c} + 2B_b\left(\frac{h}{I_c} + \frac{l}{I_b}\right) + \frac{B_b . l}{I_b} = \frac{Wl}{4} \cdot \frac{l}{I_b}$$

∴ dividing through by $\frac{1}{I_b}$ and remembering that $B_a = \frac{-B_b}{2}$.

$$B_b\left(-\frac{s}{2} + 2s + 3\right) = \frac{Wl}{4}$$

$$\frac{R}{2}(3s+6)=\frac{Wl}{4}$$

$$\frac{3R}{2}(s+2)=\frac{Wl}{4}$$

$$R=\frac{Wl}{6(s+2)} \qquad (4)$$

The B.M. Diagram is as shown on Fig. [illegible]. There are one or two interesting points to note in connection with these results.

In the first place the point of contraflexure of the columns in the second case is at two-thirds of their height from their top. If the columns of case (2) had been treated as hinged columns of two-thirds of their actual height, we should obtain the same result from formula (2) as from formula (4).

Moreover, in the limiting case in which the columns are very stiff in comparison with the beams, s approaches zero and R reaches the value $\frac{Wl}{12}$ which is the familiar result for a beam absolutely fixed at the ends; in all other cases the effect of fixing the ends of the columns is to increase the maximum bending moments upon them.

Activated Sludge Plant Operations at Manchester, England

From The Surveyor, London

The operation of the large-scale continuous flow unit for the treatment of sewage by the activated sludge process, which was brought into operation in 1917, and which occupies one third of the sedimentation tank area at the Withington works is among the matters dealt with in the report of the Manchester Rivers Department for the year ended March 31, 1921.

During the period referred to a total volume of 63,793,000 gal. of sewage, which had been screened and passed through detritus tanks, whose capacity is equal to approximately 40 minutes D. W. F., was treated in this plant. The plant was out of commission from Jan. 20 to March 14 by reason of the lack of compressed air consequent on the work of conversion from steam to electric power. Up to the former date, the plant had dealt with 62,624,000 gal. of sewage at the average rate of 241,000 gal. per day actually in operation. For several months prior to the shutting down of the plant the quantity of sewage dealt with was limited on account of a restricted air supply in consequence of the shortage of and low calorific value of the refuse burnt in the destructor, particularly during the coal strike in October. The average analytical returns are as follows:

RESULTS IN GRAINS PER GALLON

	Screened and Detritus free sewage	Effluent
Four hours' oxygen absorption	[illegible]	.49
Three minutes' oxygen absorption:		
Before incubation	.93	.21
After incubation	.	.26
[illegible]		[illegible]
[illegible]	[illegible]	1.76
Albuminoid ammonia	.50	.12
Nitrites (grains of NH_3)	....	.02
Nitrates (grains of NH_3)	....	.53
[illegible]		1.00
Average rate of treatment	241,000	
[illegible]	1.8	

Reference has been made previously to the occasional difficulty which has been experienced in the efficient settlement of the sludge due, apparently, to sudden alteration in the physical character of the sludge, which at infrequent intervals has shown a tendency to increase in bulk to an abnormal extent. Attention has been paid to this problem during the last year and observations made under working conditions, together with periodic microscopic examination of samples of sludge, tend to confirm the previously expressed opinion that this abnormal condition of sludge is due primarily to low air supply. It would appear that a low air supply over a prolonged period brings about conditions, probably arising from the incomplete aeration of fresh sewage solids, favorable to the growth of the higher organisms. Considerable numbers of "[illegible]" and "Stentor" have been found in the sludge when in this abnormal condition.

During the obligatory stoppage of this tank the opportunity was taken of thoroughly cleaning the aeration chamber. On the whole, the diffusers, which had been in continuous operation for 3½ years, were in a satisfactory condition, and it was not found necessary to renew any by reason of indifferent diffusion. No evidence has been obtained up to the present of any material choking effect, the friction of the tiles showing no appreciable increase.

Davyhulme Works Results. The following is a summary of the results obtained at the Davyhulme works:

Total flow of sewage: Main outfall 18,312,880,000 gal. Storm [illegible] 16,270,000 gal.	18,329,150,000 gal.
Total sludge removed	[illegible] tons 11.[illegible] tons per million gallons
Cost of sludge disposal	£[illegible] [illegible]s 8d £1 [illegible]s 9.4d per million gal.
Total volume of sewage filtered (primary contact beds and storm beds)	[illegible] gal. [illegible] per cent of the total sewage flow
Total volume filtered by secondary beds	[illegible] gal. [illegible] per cent of the primary effluent 28 per cent of the total sewage flow
Cost of filtration	Total £40,[illegible] 1[illegible]s [illegible]d Maintenance £11,[illegible] [illegible]s 4d Renewals £29,[illegible] 1[illegible]s 5d

	Total			Maintenance			Renewals		
	£	s	d	£	s	d	£	s	d
Per million gallons sewage flow	2	4	2.4	0	12	6.6	1	11	7.9
Per million gallons filtered	3	[illegible]	10.5	1	3	9.6	3	0	0.9

TOTAL REVENUE COST

(Apart from interest charges and repayment of debt, and exclusive of a sum of £1,515, the expenditure during the year on the activated sludge plant).

	Per million gallons.		
	£	s	d
Sludge disposal	1	13	9.1
Filtration	2	4	2.4
General expenses	1	1	11.3
	£4	19	10.8

AVERAGE COST PER HEAD OF POPULATION

For year ending March 30, 1921	28.8d
For 16 years ending March 30, 1921	12.0d

RESULTS OF TREATMENT.

(Expressed in grains per gallon.)

Four hours' oxygen absorption	
Raw sewage	6.71
Average effluent, including unfiltered tank effluent	3.29
Per cent purification	51
Albuminoid ammonia	
Raw sewage	.76
Average effluent, including unfiltered tank effluent	.34
Per cent purification	55

Research Work.—The research work undertaken during the year has been, as formerly, almost entirely concerned with matters arising out of the development of the activated sludge process.

The investigation of the nitrogen content of the sludge, referred to in the last report, has been brought to a conclusion.

Determinations were carried out on an experimental scale in the laboratory at Davyhulme and on the working scale at Withington.

It became evident during the investigation that both methods have serious limitations, and that the results obtained must be accepted with some reserve. It should, however, be stated that several separate series of experiments were made for periods varying from seven to fourteen days each, and the results quoted are the average, in the case of the Davyhulme experiments of 7, and of the Withington ones of 5 determinations.

The laboratory scale experiments at Davyhulme were carried out on the "fill and draw" system, the quantity of sewage treated varying from 30 to 200 litres. It was found that there was in each case a loss of nitrogen, due, probably, to denitrification changes during the settlement period.

On the average, 17 per cent of the total nitrogen of the sewage was recovered in the resultant sludge, or, if calculated on the organic nitrogen of the sewage, the proportion recovered was 59 per cent.

The Withington experiments were made on the continuous-flow tank in operation at those works, and extended over a period varying from a week to a fortnight. Careful measurements of sewage flow and sludge were made, and the sewage and effluents analyzed. On the average, 2,677,000 gal. of sewage were treated during an experiment. A wide variation in result was obtained, the average showing that 28 per cent of the total nitrogen, or 72 per cent of the organic nitrogen, of the sewage was recovered in the resultant sludge.

Filter-Pressing Experiments. With regard to the treatment of the sludge by pressing, particular attention has been given to (a) type of filter cloth, (b) sundry mechanical alterations—e. g., use of perforated plates, (c) thickness of cake.

The results so far obtained show (a) that for a sludge such as that obtained at the Withington works, a strong cotton twill cloth of fairly close texture is preferable to either open texture cotton cloth or jute cloths of any type, (b) that perforated plates of the type used were of no material advantage, (c) that when provision is made for the pressing of the sludge in thin cakes an improved product is obtainable.

Whilst the press trials have not yet produced the results desired, sufficient progress has been made to demonstrate that a superior product can be obtained by means of filter pressing than by any machine of the centrifugal type tried at the Withington works.

Vacuum Treatment.—Following on the lines of the work of Howarth, at Sheffield, a preliminary investigation of this method of attacking the problem of dewatering the sludge resulting from the application of the activated sludge process to the purification of sewage has been undertaken. The results so far obtained are sufficiently encouraging to warrant further consideration, and consequently it is proposed to transfer the work on to practically a working scale by utilizing, with the consent and collaboration of the Education Committee, certain machinery at the Manchester College of Technology. The necessary alterations to such plant are in hand, and it is hoped, very shortly, that it will be possible to make effective progress in this direction.

Agricultural Value of Sludge. The following trials of the resultant dried sludge from the Withington activated sludge plant are of interest in confirming the belief that the nitrogen present in activated sludge is in a form readily available for plant nutrition:

	Barley					Straw	
	Plots				Bus per acre	Total cwt	Per acre cwt
Treatment	No 1 in lbs	No 2 in lbs.	No 3 in lbs	Total lbs			
Control unmanured...	80	72	90¼	242¼	66.1	2¼	34
Activated sludge, 30 lbs. N per acre. .	103	95¾	104	302¾	82.6	3	45
Ammonium sulphate 30 lbs. N per acre	100½	84	110	294½	80.3	3¼	49
Activated sludge, 60 lbs. N per acre. .	106	100	108	314	85.6	3¼	52
Ammonium sulphate 60 lbs. N per acre .	102	104¼	100	306¼	83.5	2¾	41

	Wheat					Straw	
	Plots				Bus. per acre.	Total cwt	Per acre cwt.
Treatment.	No 1 in lbs.	No. 2 in lbs.	No. 3 in lbs.	Total lbs.			
Control unmanured...	43	56½	78	177½	44.4	3¼	49
Activated sludge, 30 lbs. N. per acre .	59¼	70	78	207¼	51.8	4	60
Ammonium sulphate, 30 lbs. N per acre. .	61¼	58	77	196¼	49	4	60
Activated sludge, 60 lbs. N. per acre .	62	69	71½	202½	50.6	4¼	64
Ammonium sulphate, 60 lbs. N. per acre. .	71½	70½	53	195	48.8	4¼	64

In conclusion it is stated that the results so far obtained from the operation of the large-scale continuous-flow activated sludge plant are such as to encourage the hope that the process may be applied successfully and economically to the purification of the city sewage in any future extension of the existing plant.

Heating Small Public Swimming Tanks.—In the pavilions on most football grounds it is now the common practice to build a bath of white glazed bricks sufficiently large to accommodate a team of players at once after play. Its capacity may be anything up to 800 gal., and the problem has been how to warm the water quickly and economically. A plan that has been adopted with success was to install a hot water apparatus of boiler and tank, of which the following are the special details. The tank was 500-gal. capacity, and the contents were heated to 145 to 150° F. to allow cold water being added. The boiler was small, but plenty of time was allowed on match days to heat the water. The heat losses were carefully considered, the tank being covered with 2 in. of plastic non-conducting material. The circulating pipes were 1¼ in. and were also covered. The hot draw-off pipe was 2 in., fitted with a 2-in. fullway valve, while the cold delivery pipe was 1½ in. The two pipes joined just before entering the bath, with a 2½-in. outlet delivering mixed water, which had to be tested by the attendant with a thermometer. This ensured rapid filling, with a minimum of heat losses. It is worth recording that the mixed water flowing into the bath had to be at about 120° F. to allow for cooling effect of the bath itself.—From the Ironmonger, London.

Labor Saving Machines for Railway Construction and Maintenance

By N. M. CLOUGHER

From The Railway Engineer

It is perhaps unwise to take a too advanced view of what may be accomplished by mechanical aids to permanent way work, but there is little doubt that during the next few years machines that will help in every day track work will become an integral part of the equipment. As traffic requirements become more stringent, greater demands are placed upon road bed and track, and this leads to the development of new methods to augment those already existing.

The electricity for the various machines that will later be described is generated by movable electric generating sets. The current is supplied from a small petrol electric generating set that moves along the line with the machine and may easily be taken off the rails, or else supplied by a large generating set which is operated with petrol, paraffin, or steam, and which generating set will give sufficient current to work various machines at the same time. In this latter case movable trolley wires are extended along the line, the power being generated at some point about halfway along the length of the wires and just off the track. By an ingenious device the large generator may be moved off the rails and put into position beside the line in five minutes. It is also supplied with road wheels for use when necessary.

Electro-Mechanical Tamping Machines Working on Great Eastern Ry.

A practice now being increasingly adopted is that of using the small generator off the track in a similar method to the large generator, using likewise the trolley wires from which the individual machines are fed. This is found to be of considerable assistance when clearing the track of machines for the passage of trains. All the machines mentioned for use along the line, with the exception of the large generating set, may be removed from the track in about one minute.

The results achieved are the outcome of many years of study, and it may be noted that the machines proved of considerable assistance to both the British and French Armies in France in connection with military railways. Up to the end of 1918 the mechanical system had been used on 3,280 miles of line and 2,350,000 ties had been worked on independently. Between July, 1920, and August, 1921, more than a quarter of a million ties were dealt with for one British railway alone. Until recently very little work was done outside France, but much was being accomplished in that country. From Jan. 1, 1914, to the outbreak of war, seven months, 23 sets of machines were working simultaneously on the P. L. M., State, Metropolitan, Eastern, and Paris-Orleans Railways, besides the work in Spain, Italy, Algeria, and Asia Minor.

The system has been used in the building of lines under the French Government in the French Zone in Morocco, where native labor was employed. A very interesting article by M. Cartault, Chief Engineer of the P. L. M., appeared in the May, 1921, issue of the Bulletin of the International Railway Association. In this article he points out that up to Jan. 1, 1921, this system of Mechanical Railway Construction and Maintenance had been used on nearly 1,000 miles of line on the P. L. M. railway alone.

Rail Renewing.—The first aim of Methodical Mechanical Renewing is first, to relay the track very quickly, and secondly, to leave only a very short space of line between the unpacked track and that which is completely ballasted ready for the resumption of normal traffic at normal speeds. The space is generally only a few rail lengths.

Before the track is touched the new rails and ties are distributed along the line; the ballast is then removed from around the ties, and with the aid of the screwing and boring machines a section of track is soon taken up and replaced by the new material. The packing machines immediately follow on to complete the operation. It is with the assistance of the various electrically operated machines that it is possible to carry out the work rapidly, and completely, so as to interfere as little as possible with traffic.

Methodical Revision.—A system now being adopted on an extensive basis is Mechanical Methodical Revision. This is carried out on main and secondary lines from every two to five years, according to their importance. The system consists in removing the ballast from around the ends of the ties to about 8 in. inside the rails, to see if the tie is in a condition to require renewing. Immediately after this operation a screwing machine is moved along the line, and this tests each screwhead to ascertain that the screw is holding. If, however, it rotates in the hole, the machine is reversed and the screw, together with the other screws in the tie, removed. The tie is then changed, or else the holes are plugged and, after the position of the chairs on the tie has been altered slightly, new holes are bored with the boring machine, which follows immediately after, and next the screws are put down in the new holes by the second screwing machine which follows the boring machine. The work is quickly carried out, and it is possible to go over a line thoroughly in this manner in a short time, with the assurance that the track is left in a sound condition.

Petrol Electric Generating Set Working in Conjunction with Electro-Mechanical Machines on Great Eastern Ry.

Tamping.—With regard to tamping, many consider that this can readily be carried out by anyone supplied with the requisite beater or tamping-bar, but experience shows that this is not the case. It is undoubtedly of great advantage to introduce a system of tamping that will render it uniform along the line as from one tie to another, and will at the same time cause tamping as carried out by different men to give a standard result.

While the roadbed ultimately obtained in this country is of a very high standard, there is considerable loss of both time and money due to the period that must elapse before a newly packed road settles down. Any method of materially shortening that time would therefore reduce the cost of this important part of permanent way work. A satisfactorily packed road is usually achieved only after the passage of many trains. The ballast beneath the tie is hard, and in many cases almost like concrete, the mass being very highly consolidated. The spaces between the pieces of stone appear to become filled up and form approximately a solid mass. With present day hand tamping one cannot expect to achieve this result at once, for although the intermittent blows of the beater will put the pieces of stone or slag close together, yet unless the blows are sufficiently strong to break the ballast gaps are bound to be left between the larger pieces of material. It is for the filling up of these gaps that one has to wait for the settling of the line and shifting of the ballast under the passage of many trains; this consolidating of the mass and filling up of air spaces also causes the line to sink. If, instead of the intermittent blows of the beater, a series of blows, so rapid that a vibration is set up, is delivered, then the pieces of ballast move about sufficiently for the pressure behind to cause the smaller pieces to flow into the spaces between the larger lumps of slag or stone.

The assistance of vibration is, therefore, essential to the early completion of a well packed line. Incidentally, vibration in itself, without the impact of repeated blows, is not sufficient to render the ballast compact. The blow is essential, but the contention is that the blow does not become effective unless a vibration is set up to cause such movement of the ballast that the temporary increasing of spaces between pieces of stone allows the smaller particles to be forced through the narrow opening and so fill up the cavity behind. It is, therefore, desirable to use a machine, and experience has shown that it is essential to have a heavy machine. This weight must be mechanically supported, but in such a way that it is available in connection with the blows. The machine should be directed by the worker, though being of such a weight that he could not support it. The method of taking the weight is of importance, and one scheme that has been used successfully under varying conditions for many years is to support the machines on a small light trolley, which readily moves along the lines as work progresses, and is moved off the track as required. Objection may be raised to the use of a trolley on the line, but it must remain for the railway companies to decide whether the advantages of a solidly packed line do not warrant arrangements being made for the use of a readily removable trolley support for a heavy type of packing machine. A question which may reasonably be expected in connection with intense packing is that as to whether packing to such solidity will not tend to lift the track. The author knows of no instance where the track has been lifted through electromechanical packing, though the matter has been tested many times. It should not, however, be assumed that if a battery of machines was put into operation definitely with the idea of lifting a track, and adequate precautions were taken to prevent overpacked ballast from oozing out from beneath the ends of the sleepers, that one might not conceivably lift the track; but under normal working conditions—which really are the true conditions—the track is not lifted.

Under the head of tamping we are bound to consider the matter of ballast, and the possibilities of tamping various types by mechanical means, and it may be said at once that no considerable difficulty is encountered in tamping any kind of ballast. The point has been raised that a blow of the intensity required to consolidate the ballast would be so great that it would break up, if not pulverize, such substances as slag. This is not the case. The ballast is packed without appreciably breaking up the slag or stone. In practice slag, or broken stone, and even sand, have successfully been packed, while during the period of the war difficulty was not experienced in working on mine earth for railways in the war area. It should, however, be pointed out that it is an important matter to secure the correct shoe to use with the hammer for each particular kind of ballast. In the case of broken stone the shoe is smaller and of quite a different design from that used for sand.

It is interesting to consider the intensity and strength of blows found desirable in electro-mechanical packing. Four hundred blows per minute are given by the hammer, and the intensity of each blow is roughly 440 lb.; this is equivalent to 176,000-lb. blows per minute. If this is compared with the amount of work put into packing a tie by hand under present conditions, it is seen that there is much to be said for electro-mechanical packing. Moreover, as there are four machines carrying out the packing of one tie at the same time, the work done on the ballast under the tie is something like 707,000-lb. blows per minute.

The necessity of having an adequate weight in the machine has been emphasized, and this decision is the result of more than 20 years' study of the subject; but regardless of this weight, the entire tamping battery may be removed from the track in about one minute. A battery consists of four machines which work in pairs, the two machines of each pair packing opposite each other and in a special manner. The battery will pack very solidly from 40 to 60 ties per hour, which is equivalent to 10 to 15 ties per man per hour. In this connection it is important to note that this should not be compared with the work performed by manual labor as the result of electro-mechanical packing is many times superior.

When working with an electro-mechanical tamping battery is is claimed that:

1. The ballast is packed more firmly and uniformly than is possible by hand.

2. It is necessary to go over the line only once, instead of having to come back several times after settling. This in itself is a great saving.

3. The line very seldom settles after packing.

4. Normal train speeds may be resumed immediately after packing is completed.

5. The packing battery can immediately follow the relaying gang, and so the line is completely finished at one time.

6. There is greater security on curves and generally an increase of public safety.

7. The hammers have shoes specially designed for each kind of ballast.

8. As the man does not take the weight of the machine he can feel to a nicety when the sleeper is fully packed

9. Similarly he can direct the blow where required with great precision.

10. As the packing is finished before the passage of a train the sleeper is not injured by being crushed on to a few sharp points of stone that frequently suffice to support it in the case of hand-packing.

11. Under proper conditions this is cheaper than by hand-packing.

As to the advantages of electro-mechanical tamping over hand tamping, reference may be made to an instance in Norfolk where a length of line on a curve was electro-mechanically tamped and a straight piece of road preceding it was packed by hand. It was found on examination after a number of hours that the hand-packed line had settled, whereas the curve, tamped by machine, had remained solid. Tamping by this method commenced on the P. L. M. Railway over 20 years ago. It was, however, due very largely to the interest in modern track-work evinced by Sir Henry Thornton and Mr. John Miller that the subject was recently investigated and tests made in this country.

Another aspect of the work that should be mentioned, though it is more applicable to Indian and African railways than to those in this country, refers to the tamping of steel ties. In the past considerable difficulty has been found in getting a solid bed of ballast inside a steel tie. Where wood is used there is a fairly flat surface, but with the hollow of a steel tie the ballast has to be forced up so that it comes into close contact with the base of the metal. Excellent results have been obtained through electro-mechanical tamping, where, in the course of a few seconds, the vibration and force will give a more solid packing that that obtained by other means, and in a test that was carried out on the Prussian State Railways in Hanover, excellent results were achieved in packing at the rate of 40 seconds per steel tie.

Screwing Machines.—The question of chair and rail fastenings is, at the present time, a live subject, and of the many types in use it will perhaps be well to deal specially with coachscrews, and add a word on through-bolts.

The coachscrew is only now coming into its own in this country, though its use abroad has been common practice for many years. It is used to some extent in America, and particularly where the frost does not cause heaving of the track in winter, and it has been estimated that, up to 1915, 1,500 miles of track had been laid with coachscrews on the American Continent. General experience abroad has been with the Vignoles, or F.B. rail, but as far as chaired roads are concerned, there are the examples of the French State lines and the Paris-Orleans Railway.

The size of the hole bored in the tie before the insertion of the screws has a marked effect on the hold, and this is a point which requires careful study. In soft wood a smaller hole can be used with advantage than would be desirable, say, in a hard oak tie. A certain influence on the selection of the right size of hole is to be found in the increased amount of energy required to put down a screw in a small hole; and this is sometimes allowed to influence the choice of size even with the knowledge that the hold under such conditions will be less than if the human factor was removed. Just before insertion in the bored tie the screw should be dipped in some substance which will act as a lubricant and protective agent. The substance selected may influence the size of the hole it is considered wise to use by rendering the operation of putting down the screw easier than otherwise would be the case.

A considerable difficulty encountered in the past in using coachscrews, and particularly where machines were utilized, has been the over-tightening of the screw. One turn after the screw is tight is sufficient to destroy the fiber of the wood on the inside of the hole, and so reduce the holding power. There is also the point that when screws are used, and the wood becomes softened or destroyed around the hole, it is difficult to tell from visual observation whether or no there is sufficient hold to keep the chair or rail in position.

The machine that has been devised to meet these requirements is worthy of description. The electro-mechanical screwing machine is of a sister type to the tamping machine, being operated on a light trolley along the line, one machine functioning at each end, i. e., over each rail. In this way the machines are used to put down or unscrew screws along the line in position. The machines similarly may also be used at a base tie depot, or may be moved along the line to where the ties are stacked. The mobility of this and the other machines is an important factor in saving the hauling of the material more than is necessary. The operation is extremely quick, and the turning torque that it is possible to exert is very great, as will be seen from the use of which the machines were put during the late war.

"Diplory" Rail Trolley in Use in Laying Side Track.

At first sight it would seem that this great available turning torque would in itself be a danger in putting down screws where one turn too much would destroy the result desired. This, however, is not the case, for on the machine there is an adjustment, so easy in its action that the machine can be caused to stop at any desired pre-determined hold to suit various classes of work, from the delicate operation of putting down a screw in a large hole in a soft tie to putting down a screw in a small hole in a hard tie. In the normal position the box spanner attached to the head of the machine is stationary, but when this engages the head of a coachscrew, the machine automatically starts and functions until the screw is sufficiently tight (as previously determined), when the machine automatically stops. In operation the machines are very quick. For example, recently at a base depot where a pair of machines were in use (with two men), it was never found possible to supply ties to the machine sufficiently quickly to exceed the machine's output, though only two men were used in putting down screws.

Another important use is in connection with the taking up of track where chairs have been fastened to the ties by means of coachscrews. It is possible by means of these machines quickly to remove all chair fastenings along a line, so that chairs and ties may be stacked or loaded separately, thus showing a great saving in handling, as also in space occupied by the cars.

These machines, like the packing and boring machines, played an important part in France during the late war both with the British and French armies. Great difficulty was experienced in removing screws from track that had been plugged, or where the holes had been bored, as the hold of the screw in the wood was increased by the screws encountering wood. It may be noted that, in each case when the machines were in operation [illegible] for 8 hours 20 minutes, the average of the two machines per hour was 1,284, which is something in excess of 20 screws per minute. This referred to taking up [illegible] track, but at the same time in France, where relaying was taking place with old ties from which the screws had been drawn, there were put down, with two machines, as many as 1,200 screws per hour, or at the rate of 20 per minute. A recent adaptation of the machine has been for tightening nuts on throughbolts. This work was carried out at a base depot. When the chaired sleepers came under the heads of the machines the nuts had been started on the threads of the throughbolts. The time

Electro-Mechanical Screwing Machine in Use in Morocco.

tion of the machine was to tighten these nuts, at the same time drawing up the lower plate into the base of the tie. A matter of some 100,000 ties were so treated. Mr. A. W. Szlumper was the first to appreciate the value of these machines for British practice, and used them on the London and South Western Railway for chairing some 150,000 ties, some with coachscrews and some with throughbolts.

Tie Boring.—In connection with tie boring, there is first of all the machine boring of ties in position along the line; secondly, in order to save unnecessary handling of material, there is the opportunity for boring ties at the stacks, whether this be at the principal tie depot of the railway or at stacks along the line where quantities may have been massed. Next there is the question of the difficulties connected with the ordinary boring machines through the change over from the two holes required for some fastenings to boring three or four holes for trenails required for maintenance ties.

The machines used to meet all these difficulties are, again, similar in general design to those for packing and screwing. They are operated on a small trolley along the line, and are also removed from the track when necessary in about one minute. It is the matter of only a few seconds to change a drill say from a ⅝ to 1⅛, and this also includes the change of guide which is attached to the arm. This guide is used for centering when boring ties, the chair itself being used as a template. It is likewise used for the same purpose when the boring is done through a special template at a base depot. Where Vignoles rails are used the guide gives the correct distance of the hole from the edge of the foot of the rail.

Regarding the mobility of this plant in a case where the entire plant, including boring machines and generating set, staging, etc., had to be moved from one part of a yard to another, the entire work took place and the machines were in operation within two hours. The machines are likewise quick in action, and although each individual hole is bored separately, yet when six holes were bored per tie, the output was over 1,000 per day. This individual boring of holes is of great importance in connection with the lack of uniformity that is often found in cast chairs.

Frequently a very slight difference in the position of the holes in a chair may throw undue strain on the casting when the screw or other fastening is inserted. With the individual method of boring, if desired, the holes can be bored through the actual chairs in position, thus ensuring the true centering of each hole. It is not essential with these machines to bore an absolutely vertical hole for in cases where an inclination is desired, the machines can be adjusted to suit requirements. It is well known that with hand boring there is a tendency to produce an oval-shaped and enlarged hole, and this is entirely obviated by machine boring. The actual time taken is from 2 to 3 seconds per hole.

As an indication of the use to which these movable machines have been put when working at a base, it may be noted that they were used recently on the Northern Railway of France for boring 4,000 ties per day. This was in connection with the adzing machines mentioned later.

In addition to the boring machine just described, one of the multiple boring type is also very largely used. This is readily movable from place to place, though it is not used for working along the line. It is supplied with rail wheels, and thus is easily moved from one place to another. It is generally operated on a siding close to stacks of ties. The output is about 1,000 ties per day. It is frequently used in conjunction with the large type of adzing machine when the ties move from the latter directly into this multiple boring machine.

Adzing.—The modern policy of removing the machines to where the work is located rather than using the additional labor of bringing the material to the machines, has caused the introduction of special machines for carrying out the operation of adzing. In many cases, probably more abroad than in this country, there is a considerable amount of re-adzing carried out, and frequently when this is done the ties are re-adzed in position, the machine actually being taken along the line and the new surface given to the wood without removing it from the road. This is found beneficial chiefly in two cases—firstly, when the chair or rail has worked itself into the tie unduly or unevenly; secondly, when the fastenings have become insecure, and the old holes are plugged, and new ones bored. This machine re-adzes the sleeper in 5 to 10 seconds.

The large adzing machine is in size and general manipulation very similar to the multiple boring machine. It is operated by two men, both ends of the tie being adzed at the same time. Any desired cut can be arranged, as, for example, the flat surface for chairs or the additional cutting to form a seat for F.B. rails. The cut in both the adzing and re-adzing machines is made by means of a high-speed milling cutter, as it is found that in this way the wood is not torn, as is so often the case with the ordinary adzing blades. The adzing machine has an output of from 1,000 to 2,000 ties per day for new ties. Naturally, this output is reduced when old ties are being re-adzed for future use, due to the fine particles of stone and sand that have become imbedded in the wood.

Electro-Mechanical Boring Machine in Use in Morocco.

It is of very considerable benefit in a tie depot to be able easily to move the adzing and boring machines from one stack to another, and the ties feeding from the adzing to the boring machines considerably reduce the amount of labor necessary. To take the case of the Northern Railway of France the method adopted was to keep the adzing and boring machines together with their petrol-electric generating set, on the lines in the tie depot, so that they could readily change from one place to another. The empty cars were then backed into the siding, so that after passing through the machines the ties were at once mounted into the cars for removal to the creosoting tanks, the whole space occupied from stacks to cars, including adzing and boring, was the matter of only a few yards.

Rail Drilling.—The drill next to be described is a machine designed specially for the drilling of rails, and one worked out under actual conditions of practical track work. The rail drill, like the other machines, is electrically operated, a motor of the required power being supplied with current from an electric generating set. The machine is carried on a light trolley, but in this case there is only one machine pivoted at the center, so that either rail may be drilled as required. The drill works at 200 revolutions per minute, and drills a rail in about 30 seconds. In actual practice the output is about 40 holes per hour, or about one every 1½ minutes on the average, the extra time being taken up in moving the machine, etc. The value is not alone in drilling holes for fishbolts, as it has a very important use in drilling holes for bonding rails for electric traction. There are two types of rail drill, one working from the outside, and the other pattern working from the inside of the rail.

Rail Sawing.—The need of a new type of rail saw became apparent during the late war, and as a result a readily movable power driven rail saw was introduced for use along the line, and this has met with considerable success. Blades of the hacksaw type are used, and a rail is cut through in from 6 to 10 minutes, leaving a square and clean cut face.

Loosening Ballast.—So much energy has been expended in pick work on hard consolidated ballast that it is a matter for surprise that a suitable machine has not previously been developed for loosening ballast ready for removal by shovel. The individual machine, which is mounted on a trolley, is moved along the line, and rapidly stirs up and loosens the ballast between and around ties. As the machine is quick in action there results a considerable saving in both time and labor.

Rust Prevention in Reinforced Concrete

The development of rust in reinforced concrete and the best methods of prevention have recently been examined by Dr. Goslich of Berlin with the assistance of committee. Three typical Portland cements were used, the cement mortars consisting of cement and sand in the ratio 1:2, 1:3, and 1:5, respectively, and the reinforcing rods 0.4 in. diameter were covered to various extents. The results, according to Zement, of Berlin, show that to ensure the reinforcement being properly protected it must be covered with at least 0.8 in. of 1:2 cement-mortar. The sizes of the sand grains and of the interstices between them are less important than the richness of the mixture. A 1:2 mixture is superior to 1:3 as regards prevention of rusting, and 1:5 is satisfactory if the reinforcement is sufficiently deeply embedded.

If the conditions are sufficiently severe, rusting appears to be inevitable unless the reinforcement has been covered with a waterproofing agent.

A Subsiding Town.—The difficulties connected with the sewerage, sewage disposal works, buildings, and other structures in Northwich, England, will rank as the greatest which any Urban Council in the country or any engineers have to contend with. These are consequent upon the ever-recurring subsidences over an area of about one square mile, due to brine-pumping, the solid salt removed each year being equivalent to about 1 ft. in thickness. The area of subsidence is clearly defined, and has not appreciably extended during the past 30 years, but within it the points affected are frequently changing and the pools of water due to subsidence cover an area of more than 120 acres, some of them being over 80 ft. in depth. In the town itself portions of the main street have had to be raised nearly 6 ft. at intervals of about 10 years, and practically all the buildings are constructed on the frame principle, so that they can be lifted bodily off their foundations by means of jacks and then underpinned with brickwork or concrete. Two important buildings are of reinforced concrete skeleton construction, which has proved highly satisfactory in withstanding the effects of subsidence. Reinforced concrete was used in the construction of the main and subsidiary pumping station buildings; and in the area of subsidence steel tubes have been used in some instances and in some places experiments have been made with a type of ball-and-socket pipe.—From Municipal Engineering, London.

Stabilising Wages in British Public Works Construction

From The Surveyor, London

Municipal and other public authorities have, over the last three years, been bewildered by the rapid and frequent changes of wages which have been forced upon them by reason of wage agreements made in the various industries they follow in connection with the public works, and there has been a very strong tendency on their part to postpone the commencement of these works until such time as they can estimate with some degree of accuracy the capital outlay involved.

By the beginning of last year wages to unskilled laborers had increased to a rate which was more than three and a half times the pre-war level, while the cost of living was never more than just over two and a half times the pre-war cost of living, and in view of this remarkable disparity between the cost of living increase and wage increase, the undertakers of large public works were compelled to close their purses and adopt the strictest economy in this particular class of work. While the distress caused by the unemployment brought about in all the various industries in this country owing to purchasers similarly closing their purses while the cost of production remained so high, has resulted in some public works being carried out for relief of this distress, the really important developments of water supply, road, dock, rail and other improvements have not even yet been embarked upon by the employing authorities, owing to their lack of confidence in the accuracy of the estimates of cost which are made on their behalf.

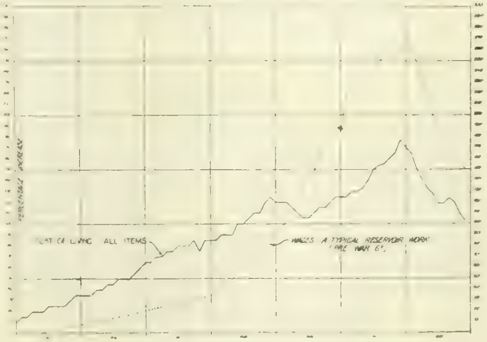


Fig. 1.

Experienced trade union leaders, however, have fully grasped the importance to the men they represent of obtaining a stabilization of wages which will give that confidence to employing authorities which will enable them to make such accurate estimates, and it may not be sufficiently known that in regard to constructional work, other than building, an agreement was entered into in March of last year between the representatives of the navvy and laborer and other workers engaged on civil engineering and public works construction and the Federation of Civil Engineering Contractors (supported by representatives of municipalities carrying out waterworks by administration) under which the serious disparity between the cost of living percentage increase and wage increase was considerably reduced, and under which provision was made for the future, so that each month's cost-of-living figure is at the same time an index to and a determining factor in the rate of wages which is to be paid in the month following.

This agreement is being operated in a very considerable degree by local authorities as well as by contractors, and its chief feature from the employing authorities' point of view is that it does not, as in the case of the building trade (under whose present arrangement wages up to August, 1922, will be affected by the cost of living in July, 1921), lag months behind the fall in the cost of living, in obtaining a relative fall in the wages, but is operating smoothly and satisfactorily each month by reason of the general good will of both [illegible] to the [illegible] to carry out their undertaking to the full.

Figure 1 shows very closely the operation of this agreement with since the initial reductions were made the wage falling in exact relation to the monthly fall in the cost of living, and there can be little doubt that employers will be justified in considering that this wage agreement has restored an element of security in the industry with regard to wages. The cost-of-living figure may be still further reduced, but employers can feel satisfied that the wages of the operatives employed on public works will fall in a relative degree from month to month.

The present basic rate of wages to navvies (with the cost-of-living index figure at 105) is, in the County of London, 1s. 10d. (45 ct.); in Class 1 towns, defined as "towns which, by reason of their industrial life usually paid to the workmen employed in their various industries and in the services of the local authority higher rates than were paid generally in other urban areas throughout England and Wales," 1s. 5d. (34 ct.); in Class 2 places, defined as "all areas not in Class 1, which are geographically within large industrial areas, or, being outside, are themselves industrial in character, in which workmen employed in the various industries and in the public services were usually paid similar wages to the workmen in towns within the areas," 1s. 4d. (32 ct.), and in Class 3 places, defined as "areas and towns other than Class 1 and Class 2 (excepting the County of London and specially rated areas under Rule 1 (2))," 1s. 3d. (30 ct.); and for every fall of 7½ points from 105 per cent in the cost-of-living figure these wages fall ½d. (1 ct.) per hour.

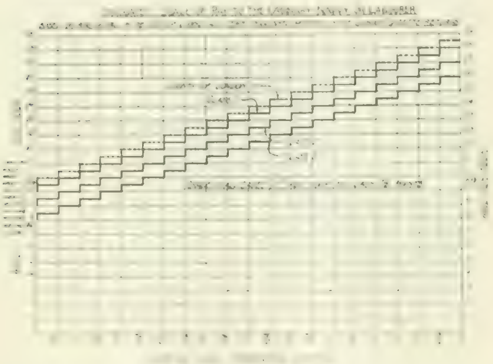


Fig. 2.

Figure 2 shows at a glance the wage rates which operate in the various areas whenever the cost-of-living index figure is published.

Method of Extinguishing Oil Fires. The problem of dealing with fires occurring on premises where oil is stored in considerable quantities is one which chief officers are called upon to face in these days when industrial and other companies use tanks containing thousands of gallons of highly inflammable liquids. In the case of a recent fire occurring on premises of the kind, a few hours reduced the plant to a mass of twisted iron with rivulets of flaming oil, petrol and naphtha creeping along the smoking ground. Until a few years ago the only known method of fighting fires of this type was with water and sand. Other methods have since been evolved, and an ingenious apparatus has been devised for dealing with outbreaks of the kind. It consists of a large metal cylinder or tower about 20 ft. high. The lower portion contains a solution of bicarbonate of soda and soap bark. Above this is a tank holding sulphuric acid with a pipe leading to the solution below. A heavy hammer is suspended above by means of links which will melt at 212°. Should a fire start, the heat melts the chains, the hammer falls on a plunger, which fractures the glass and allows the acid to combine with the solution. Carbonic acid gas is immediately generated, and a foaming torrent is discharged over the surface of the flaming tank. It is claimed that this method of extinguishing fires in petrol tanks has proved very effective.—From Municipal Engineering, London.

Waves—Their Formation, Action and Effect on Marine Works

By ERNEST LATHAM,

[illegible] Water and [illegible], London

There are not many references to wave action in existing textbooks, but Prof. Ernest Matthews, in his book on "Coast Erosion and Protection," deals in his first chapter with the subject. Probably no other volume will be found to contain such a valuable collection of photographs, taken during storms, under obviously difficult conditions, and the reader interested in this subject is advised to add this work to his collection.*

Determination of Wave Height and Range. The theory of wave action is somewhat indeterminate and there is a valuable contribution to the subject given by C. Colson in an appendix to his book. He refers, in the first instance, to a formula of the late T. Stevenson, used for the purpose of determining the height of waves. The formula quoted is

$$h = 1.5\sqrt{d}$$

where h is the height of waves in feet and d is the length of exposure in miles or the "fetch."

The height of waves is deceptive, but in conjunction with other physical properties has a direct bearing on the dynamical force which the wave is capable of exerting. If this formula is applied to a "fetch" of [illegible]000 miles, a wave height of some 60 ft. is obtained. In the author's opinion, even under the worst conditions there is no reliable record of any wave of such height. It is not clear from Stevenson's formula whether the height referred to is the vertical interval between crest and trough or the height of wave above mean sea level, but it is presumed the former. Mr. Colson had apparently doubt about this formula, as he modified it for short fetches. This indicates appreciation on his part of the most important but obscure function in wave action, namely, the phenomenon known as "range."

Range may really be regarded as the potential damaging effect of a travelling wave and is therefore a function of its velocity, height and length. While, owing to the nature of the sea bed, or to the existence of lateral constrictions or to other causes, the ratios between these variables may alter, the range of the wave remains virtually the same until its potential energy commences to be dissipated.

The author suggested in 1919 that probably an attempt might be made to express the term "range" mathematically. As a result the following suggested formula was put forward by Mr. A. E. Carey (see p. [illegible], Proc., Inst. C. E., 1921, vol. ccix.):

$$R = \frac{\sqrt{V} \cdot fH}{L} = \frac{\sqrt{v} \cdot fh}{l}$$

where v = velocity in feet per second.
h = height in feet.
l = interval of waves in feet.
and f = a factor to be determined by experiment.

V, H, and L would represent the same components of the wave after passing a harbor entrance or other constriction.

R would then be the range expressed in units to be defined by experiment.

The higher the value of the range factor in a wave the greater the potential energy of the wave as regards its capacity for doing damage.

From the above considerations it is obvious that actual observation on a coast line is of more value than any theoretical attempt at calculation. The dynamical force exerted by a wave depends so much on local conditions that the theoretical results from open sea calculations are generally quite inadequate. For example, the effect of an ocean wave approaching a cliff barrier with deep water close in is very different to the effect of the same wave approaching a gradually sloping and shallow foreshore, or again to its behavior after constriction in the narrow entrance of a harbor mouth.

Types of Waves. A great deal of study has been given to wave action, but it is admitted that there are so many variable functions that the theory of wave action is of little practical value. There are, however, several different types of sea whose action on marine works is well understood. These are (1) the travelling wave, (2) ground swell, (3) broken sea, (4) breaking sea, and (5) the oscillatory wave. These do not include the free tidal wave, but may be defined as follow:

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*The subjects of wave formation and action are also dealt with in the following books: "Harbours and Docks," Vol. I (L. F. Vernon-Harcourt), Clarendon Press; "The Sea Coast" (W. H. Wheeler), Longmans, Green and Co.; "Manual of Hydrology" (Nathaniel Beardmore), Waterlow and Sons; "Notes on Docks and Dock Construction" (C. Colson), Longmans, Green and Co.; "Tidal Lands" (Carey and Oliver), Blackie and Sons; "Maintenance of Foreshores," Crosby Lockwood; "Wave Impact on Engineering Structures" (Prof. A. H. Gibson), Institution of Civil Engineers.

(1) The travelling wave is one in which the particles of water have a definite forward movement.

(2) A ground swell is the type of sea remaining after the wind drops; it is, of course, transmitted to areas beyond the storm zone and is caused by the sub-surface velocity exceeding the surface velocity.

(3) A broken sea occurs when the "range" is restricted from increasing, i. e., the intervals between waves and the height of waves are small and cannot increase owing to shoals, currents or changes of wind. This class of sea is not at all dangerous from the engineer's point of view unless superimposed on travelling waves.

(4) A breaking sea occurs in shallow water when the wave collapses forward owing to the arrest of its lower portion on the foreshore or sea bed. The travelling wave, on reaching the coast, generally breaks in this fashion.

(5) The oscillatory wave is one in which the particles of water have no forward movement. They are not damaging in effect as a rule.

The worst sea from the engineer's point of view is the breaking sea where the final onslaught of the wave is exactly on the alignment of any defensive works, sea wall, mole, quay, etc.

Wave Pressures.—Prof. Arnold Hartley Gibson, D. Sc., in his paper entitled "Wave Impact on Engineering Structures," comes to some remarkable conclusions. These mostly indicate that whatever the face pressure of the wave may be (i. e., exerted against a vertical plane), these pressures may be developed up to pressures 16 times as great if there is any open joint or fissures presented in that plane. This at once explains the necessity of wide spans in open structures and an unbroken surface in solid structures where such are exposed to the action of the sea.

Another important point to remember is that if, by reason of vertical structures an oncoming wave is thrown vertically upwards, a very intense downward pressure is caused by the subsequent descent of the water which, in exposed situations may safely be taken as reaching 700 lb. per square foot. This is a very important action, and the late W. T. Douglass expressed the opinion in 1911 that probably 50 per cent of sea wall failures were due to this downward action destroying the surfacing behind the sea wall proper.

Examples of Damage by Wave Action.—Both A. E. Carey and Prof. E. R. Matthews in their works give interesting records of damage by wave action, and cite extraordinary occurrences in respect of excessive weights moved, particularly in respect of damages to harbor works in the North of Scotland. One of the most remarkable effects noted by the author was on the South Breakwater, Dover, when under construction in 1906. Concrete blocks were stacked by gantry cranes along the surface of the breakwater where it had been completed to formation level. In a very heavy storm in November of that year high waves broke over this breakwater and actually shifted these blocks where stacked three deep, thus moving a column of concrete 120 tons in weight. These concrete blocks would have been swept right over the breakwater had they not encountered a quite unintentional barrier. Down the center of the breakwater, which was 45 ft. wide, the contractor had laid a track of flat bottomed rails temporarily secured by jag bolts grouted into the permanent work. The movement of these large stacks of blocks was arrested by these rails, and, although the track and rails were twisted, the fishplates fortunately held and this prevented a disaster, which would have delayed the construction of the breakwater for many months, as the blocks would have been thrown landwords against the contractor's falseworks, which they would undoubtedly have damaged.

In a paper read by A. E. Carey before the Society of Arts in 1907 an original photograph of this occurrence was reproduced. The above case of wave action has been referred to at length, as it is probably the most reliable record of an excessive weight moved by the action of the sea well above high-water mark.

Velocity of Waves.—The late C. F. Vernon-Harcourt deals with the theory of vertical oscillation in his book on "Harbors and Docks" but there is some doubt whether the generation of waves can be affected by wind without a definite forward motion being imparted to the particles of water. There is, however, a valuable paragraph on the velocity of waves, and, from Sir G. Airy's investigations therein referred to it would appear that the velocity of the wave, while increasing with its length (i. e., from crest to crest), is also affected by the depth of the water, but that beyond a certain critical depth the velocity ceases to be affected thereby. There is some confusion of ideas as to what is meant by the "velocity" of waves. Such velocities have been observed by Scott Russell and presumably represent not forward velocities but the period of undulation divided into the wave length and this does not appear to be a measure of velocity at all. For example, a purely undulatory wave, which really does not exist by itself at all, would not be capable of doing any material damage to marine works by direct impact, and the engineer would then merely have to legislate for the simple hydrostatic pressures caused by the undulation. This is fairly evident by the breaking of waves against the side of a large ship after the aerial storm has abated. The real physical condition of most waves probably lies in a combination of both forward and oscillatory movements, while it may safely be said that the civil engineer has chiefly to deal with the wave of translation. Vernon-Harcourt deals exhaustively with the subject and perhaps unconsciously has thrown a good deal of light on the use of the term "range," and from the information he gives it is clear that there are waves of translation in a deep and open sea. There is some difficulty in directly measuring the force of the waves by means of a dynomometer which, by reason of the function it has to perform, has to be heavily constructed and the pressure recording plane designed to travel, this plane has considerable inertia, and the errors of observation are therefore obviously great. There is room for further experiment, and probably a purely hydraulic gauge could be designed.

Force of Wave Action.—Many text books recite at length instances of the intense force of wave action, but these are so variable and conditions so different that they cannot really form the basis of any calculation or value. As, however, there is definite evidence of masonry masses of over 1,300 tons being moved by wave action, historical data is of value as indicating the importance of securing the most rigid structure possible and ensuring perfect joints between the component parts of masonry or concrete works. These requirements call for the most careful specification and supervision, which is more than ever required in the case of monolithic concrete structures where a bad "bond" between old and new work is a real source of danger.

What may be classed as the free tidal wave is really of little practical importance and can best be regarded as the phenomenon which would occur on the normal diurnal tides provided there were no storm disturbances anywhere on the world's surface. Under such conditions the only physical effect would be a slow rise and fall in water level increasing through constrictions and in estuaries. Directly the first effect of land constriction is felt the oscillatory motion of a tidal wave becomes partially translatory, but more in the sense of a "current' than a wave. This statement is not universally true, as the tidal waves in certain cases become held back and, suddenly advancing, cause a "bore wave," which is, of course, capable of damaging effect, as, for example, in the case of the River Severn. It must be made clear, however, that these tidal waves cause normal hydraulic current, subject to the ordinary hydraulic laws, but they cause no damage beyond that resulting from the scouring currents produced (the few isolated cases of bore waves excepted).

On the cycle of tidal waves are superimposed the wind waves and these comprise an entirely different series and have definite damaging effects as previously cited. By virtue of the fact that wind waves are not simply oscillatory, their "range" is determined by the force of the wind and the condition of the tidal waves on which they are superimposed. The depths of water also effect these waves and they are the class of waves which may frequently be seen breaking on the coastline during storms. The after-storm wave is substantially of a different character, but it is the same class of wave altered only as to condition. The alteration is principally due to the fact that the sub-surface velocity has be-much higher than the surface velocity creating what is known as "ground swell" previously referred to.

[illegible] deals in some detail with the subject of tidal waves in his book, and W. F. Wheeler, contrary to the above view, considers that true tidal waves do "break" on the foreshore even when there is no wind, but the author is of opinion that this would not occur if still conditions existed simultaneously throughout the world. Mr. Wheeler further considered the tidal wave to be entirely undulatory, and he did not admit of any forward effect being produced until such a wave reached shoal water.

Compressed Air as Wave Reducing Agent. In recent years Philip Brasher has successfully experimented with compressed air as a wave reducing agent, and several of his installations have been put down in the United States. He has ascertained that by releasing compressed air from a perforated pipe line laid on the sea bed, wave action is materially reduced. The author estimates from the data supplied him that roughly one brake horsepower per lineal foot of pipe line is required in a depth of 20 ft. of water. Where a narrow and dangerous harbor entrance requires protection, and where power is available the Brasher system seems worth while experimenting with, but otherwise the expenditure of energy seems disproportionate to the advantages to be gained.

Sewage Disposal in the Tropics

From The Surveyor, London

An interesting insight into the special problems which have to be faced in providing up-to-date means of sewage disposal in a tropical country is furnished by a report of Dr. Gilbert J. Fowler, in which consideration is given to the carrying out of a scheme for Kuala Lumpur, Ipoh, Seremban and Klang, in the Federated Malay States. The report deals broadly with certain leading factors conditioning the whole question and a number of recommendations are made for immediate action.

In the first place, Dr. Fowler urges that a clear decision should be arrived at as to the necessity for a water-carriage system of sewerage. Objection, he says, may be taken on the score of expense and the lack of very clear evidence, from actual vital statistics, of the sanitary benefits to be obtained, but his personal view is that it is an inevitable demand based on the natural desire for greater cleanliness and amenity which accompanies a higher standard of living. In all the four towns which he has visited modern conditions of life prevail and there is a growing percentage of pleasant residential bungalows, the life in which is impaired by the primitive methods of sewage disposal in use, which are often indeed less sanitary than those employed in the town areas. In the crowded town areas, provided a system can be devised which may be relied upon to function satisfactorily, the rapid removal of excreta and other noxious material from the vicinity of houses is manifestly greatly to be desired.

Water Supply. Dr. Fowler states that in all the towns which he visited the water supply appears to be ample or can be readily made so. The water in each case is derived from mountain streams impounded to a greater or less extent. It is very soft, and from appearance should be of a high standard of purity needing only to be filtered through a shallow layer of sand to remove floating particles, leaves, etc., in accordance with the present practice. At the same time, he suggests that it is highly desirable that regular analyses, and especially bacteriological examinations should be made, so that occasional pollution due to weather or other conditions may be quickly detected and steps taken to handle the situation and prevent its recurrence.

Although the towns are thus fortunate in having an ample supply of good water, and are spared the expense of costly purification works, he makes it clear that every care should be exercised to ensure economy in the use of water if a water-carriage system of sewage disposal is adopted. Experience has shown that unless special precautions are taken, great waste of water is likely to take place in town areas of the character met with in the Federated Malay States. In this connection he points out the necessity for metering the water, as far as possible, at every separate connection, and for the supplies of special devices to prevent the tendency to waste of water from taps. Apart from waste of water there is a natural increase in consumption which must be expected, owing to considerable increase in population due to trade development and the more lavish use of water for bathing, etc.

Character of Rivers.—The rivers in Malaya which Dr. Fowler has seen are most of them somewhat shallow streams, flowing rapidly in tortuous channels and bearing a heavy burden of silt from the tin mining areas.

Little information, he states, exists as to the self-purifying power of these rivers in the event of sewage or sewage effluent being turned into them in quantity. Rivers such as those in China, the silt in which is derived mainly from the washings of agricultural areas, have, he continues, a remarkable power of oxidizing and sewage which may be turned into them owing to the presence in abundance of the necessary oxidizing bacteria, but, he says, it is by no means necessarily the case that Malayan rivers, originating as mountain streams and receiving in their course debris of the tin mines have such purifying power, although their rapidity of flow may be sufficient mechanically to remove much waste matter.

The writer of the report observes that a question upon which information is needed is the effect of the discharge of sewage or sewage effluent in the rate of deposit of the finer portions of silt in the river. "Experience has shown," he says, "that the addition of sewage to a silt laden water tends to cause settlement of the fine silt. This will probably be especially the case with Malayan rivers the water in which is very soft. Any disturbance of the saline content is thus the more likely to cause deposition of fine colloidal particles."

Dr. Fowler has had some experience in connection with the deposition of tin slimes in Cornwall, and he thinks it highly probable that much tin goes to waste in Malayan rivers. The condition of the rivers being such as is described, he considers there is no likelihood of their being used as sources of water supply for drinking purposes. The necessity for purifying sewage to the extent required where the purity of a water supply has to be safeguarded does not therefore arise, and the treatment adopted need only be sufficient to prevent nuisance and deposit in the river, and to conserve as much as possible of the manurial value of the sewage for the land.

Power Resources.—In several cases it will be necessary to pump portions at any rate of the sewage. In tropical countries it is most necessary to provide sewer gradients giving as high a velocity as possible to avoid local deposits and consequent fermentation and nuisance. In consequence, says Dr. Fowler, there should be no inducement to minimize gradients through fear of the expense of pumping. For all these reasons, he thinks, investigations which are in hand with the object of providing cheap hydro-electric power are to be welcomed. Meanwhile pending provision of hydro-electric power, he regards it as probable that some form of oil engine will be the best source of power to adopt, it being necessary, e. g., in the case of pumping storm water, that the power available should be capable of being brought into action without any delay.

Dr. Fowler next points out that, in considering both the dimensions and character of the sewers to be provided and the method of treatment to be adopted for the purification of the sewage, it is necessary to decide exactly what material should be received into the sewers. In this connection (a) town areas, (b) bungalow areas, and (c) "kampong" areas, are considered in turn.

Sewerage for Town Areas. The author of the report remarks that it would be satisfactory from the point of view in cost if only excreta and "sullage" (i. e., urine and liquid waste from kitchen, etc.), could be received into the sewers to be constructed. This, however, appears to be impossible in many cases, at any rate in the town areas. The cleaning of vegetables is carried out in the backyards of the houses in the town areas, and it does not seem practicable to avoid the admission to the sewer of the rain water falling on this backyard area. He suggests, however, that every effort should be made to minimize the amount of rain water thus admitted so as to keep the size of the sewers within reasonable dimensions.

The sewer system, in fact, should be as nearly as possible what is known as the separate system. In order to obviate the necessity of a flushing cistern to every house, with consequent probable waste of water owing to mishandling, etc., Dr. Fowler agrees that small groups of houses might be treated as elements of a communal latrine, the present privies where the buckets are now placed being connected together by a common flushing channel closed except at the privy where a suitable seat would be provided. This flushing channel would be cleansed periodically by a powerful automatic flush from a cistern which would be subject to regular official inspection. The flush channels would be connected to the sewer proper through a large grid laid horizontally and of a mesh sufficient to retain articles likely to block the sewer. The foul water from the kitchen and bath water would enter the sewer at the same point, having passed through a fine meshed grid or sieve countersunk in the cement paving of the yard.

In view of sudden tropical showers and consequent heavy run off from backyards storm-overflows would have to be provided at suitable intervals from the sewers discharging into the present open rain-water gullies. At these storm-overflows it might be well to insert silt traps of ample dimensions to intercept sand and other debris, although the necessity for this was not so clear as in India where in every household sand was used for cleaning brass vessels and cooking pots.

Dr. Fowler proposes that the present public dry latrines should at the earliest possible moment be converted into water-carriage latrines, as the present arrangements can hardly help being extremely offensive. The use of such public water-flushed latrines will, he remarks, accustom the people to the use of water-carriage. Moreover, pending a complete system, a dump-hole might be provided in connection with such latrines through which the contents of the present buckets might be discharged into the sewers together with an ample flush of water. The result of this would be that the expense of carting the buckets long distances with its offensive accompaniments would be reduced.

Bungalow Areas. It appears to Dr. Fowler that the connection of bungalows to the sewers and the provision of modern sanitary equipment is quite practicable where the distance between bungalows does not exceed 100 yards. This might be taken roughly as the economic limit, with, of course, necessary exceptions. In other cases some special means of treatment of the sewage either by a small septic tank or other device might properly be adopted. In many cases it would be possible to eliminate bath water which is only slightly polluted and also the greater part of the roof water from the sewers in the case of bungalows and admit only excreta and sullage.

"Kampong" Areas.—Dr. Fowler has examined a number of these in the vicinity of Ipoh and while isolated habitations surrounded by jungle do not appear to require much attention, their various waste products being inoffensively disposed of in natural ways, yet in more closely packed collections of Malay dwellings offensive conditions arise. The only practicable remedy in such circumstances appears to be the provision of buckets which may be systematically collected and the contents "dumped" into the nearest sewer, the sullage being drained off into various natural ditches as at present.

The report suggests that the problems presented by "Kampong" areas might well receive the special attention of the town planner.

Treatment of Sewage.—Dr. Fowler has no hesitation in recommending that wherever possible the activated sludge method of purifying sewage should be adopted "as it is the only method, other than sewage farming which permits the conservation of the nitrogen in the sewage."

The Singapore Commission, he observes, recommends sewage farms, "but the difficulty about these, as ordinarily conducted, in any countries but those deficient in water, is that in order to bring enough fertilizing elements to the soil, more water has to be added than the soil needs, and so unsatisfactory and swampy conditions arise and there is considerable risk of nuisance, as well as loss of nitrogen."

The cost of sewerage and sewage disposal works for a total of 250,000 people, which is roughly the population of the four towns concerned, is put at £1,500,000, equal to £6 per head.

Early Reinforced Concrete Bridges in Great Britain. The first ferro-concrete bridge in England was built in 1900 for the Hampshire County Council. The bridge in question is one on a county highway at Chewton, near Alton. After several bridges had been constructed in England, the first structure of the kind in Scotland was built in 1903. Situated on the property of the Dundee Harbor Trust, this bridge carries railway as well as road traffic and therefore may be cited as the first ferro-concrete railway bridge in Great Britain. In 1905 the first ferro-concrete viaduct in Ireland was erected. Although last of the divisions of the kingdom to commence ferro-concrete bridge building, Wales has now an excellent series of Hennebique bridges. The first works of the kind were two small highway bridges at Wyddgrys and Glanyrafonddu, built in 1907.—From Ferro-Concrete, London.

Advantages of Railway Electrification

By VINCENT RAVEN.

From The Railway Engineer, London. Abstract of a Paper Read Before the North East Coast Institution of Engineers and Shipbuilders.

The paper deals generally with some of the advantages which may result from the substitution of electric for steam locomotive operation, with special reference to experience gained on the North Eastern Railway.

The mechanical disadvantages of the steam locomotive may briefly be summarized as follows:

The locomotive being a complete independent unit its power cannot be greater than the capacity of the boiler.

To increase the boiler capacity obviously implies increased dimensions and weight, both of which offer grave difficulties in regard to clearances and strengthening of bridge structures.

It is known that on many railways in Britain the limit of weight has been reached, and further development of power is only possible at enormous expense.

The boiler, cylinders, valve gear, crank-shafts and all reciprocating parts are costly to maintain. Turntables, fuelling plant and water supply appliances must be provided.

The cab is small and open to the weather, involving discomfort to the locomotive crew.

The locomotive radiates heat and uses coal all the time steam is up, that is, during many hours when it is doing no work and either standing by or coasting.

The wear and tear of the locomotive on the track is considerably increased by the impossibility of accurately balancing the reciprocating parts.

These objections do not apply to the electric locomotive, and, in addition, it possesses the following advantages:

Simplicity of mechanical construction and operation.

Increased power of acceleration.

Higher scheduled speed due to the possibility of heavy short period overloads resulting in more frequent service and increased use of existing tracks. Uniform turning effort resulting in better factor of adhesion at starting and on gradients.

Absence of all reciprocating movement and accurate balance of all rotating parts.

Facilities for driving from either end of a locomotive.

Accessibility of mechanical and electrical parts.

Better accommodation for locomotive crew by reason of increased cab area and by closing in and heating the cab.

Possibility of coupling two or more locomotives together under the control of a single driver.

To these must be added the electric locomotive's availability for service at a moment's notice, as against the lengthy processes of preparing and putting away a steam locomotive; and the small amount of attention needed by the electric motor while in operation, enabling it to remain in revenue-earning service continuously for at least 20 hours in every 24.

Electric and Steam Locomotives Compared.—Complete utilization of the electric locomotive can be obtained by the adoption of a system of "pooling." In addition to this, since the only requirements of the electric locomotives in the ordinary conditions of service consist of cleaning and adjustments carried out in the ordinary routine inspection, it is possible when some occasional derangement of schedule occurs, to keep these engines in continuous service for two or three days, by omitting the cleaning and routine inspection for that period. It should, of course, be understood that the engine is in good repair; but provided this is the case there is nothing to prevent continuous service. Such an extension of time in service would not be practicable with steam working. This advantage applies particularly to the case of the electric shunting locomotives, which are frequently kept in service for six days continuously.

Examples are given of such utilization on the New York, New Haven & Hartford R. R., and on the Newport & Shildon branch of the North Eastern Railway. On this branch the mileage run by the electric engines today is 116 train-miles per day per engine in traffic, as compared with 55 for the steam engines in 1914.

The fundamental difference between an electric locomotive and a steam engine lies in the fact that while the latter generates its own power the former is only a transformer of the power which is generated at the power station or stations into haulage power on the track. One consequence of this difference is that the working of a steam engine depends to a large extent on the skill of the crew in attending to the fire and the water level, and in looking after a large number of mechanical parts and generally nursing the engine so as to get the best out of it. The working and condition of an electric locomotive is not nearly so dependent upon the skill of the driver and his assistant. Full power is always available and the power and speed which can be developed at any moment are only limited by the [illegible] of the electrical equipment and by the mechanical construction.

The driver of an electric locomotive need never hesitate to use the full power for the sake of sparing the locomotive, and all trains within the range of load for which the locomotive is designed can be hauled up the maximum gradient at full speed. It is evident, too, that the overload capacity of the generating station or stations will be very much greater than that of a single boiler regarded as a single locomotive, and since the capacity of an electric motor is in practice only limited by heating effect, it follows that an electric locomotive is capable of a very large overload for a short period. That is to say, that provided the average work performed does not exceed that for which the locomotive was designed the work done may, for short periods, be greatly in excess of the average. The result of this is that the speed when climbing a gradient can be much greater with an electric locomotive than with a steam locomotive of the same nominal horsepower, because the extra work done by the former is compensated for by the light duty during periods of running on the level and on falling gradients when the motors have time to cool down.

With electric working the general average speed can be considerably increased without any increase in the maximum speed. If other factors, such as drawgear and braking facilities permit, this characteristic of electric locomotive operation would allow goods trains to travel at an average speed more nearly approaching that of passenger traffic. The result of this would be a more regular flow of traffic over the line and the necessity for side tracking the goods trains to allow passenger trains to pass would be reduced. It is a fact that a high general average speed of travel increases the total capacity of the line.

Increased average speed of travel and better traffic working also follow upon electrification, which may avoid the necessity of incurring large capital outlay, for additional track construction and other work.

Savings Effected by Electric Operation. Sir Vincent Raven gives an example of savings which electrification would effect on an existing steam railway, 250 miles single track, which it has now been decided to electrify. Apart from obviating considerable track doubling and new lines, these are shown to amount to a reduction in the annual train mileage of through goods trains of about 25 per cent for the same total ton mileage. At the same time the average speed of travel would be increased, the total time for the double journey being reduced from about 56 hours to 26. The saving in new cars due to this acceleration of service was estimated to amount to approximately 12,340-ton cars, or the equivalent.

On the Chicago, Milwaukee & St. Paul Ry., Mr. Beeukes, the electrical engineer, has estimated from actual records that electrification has enabled about 30 per cent more tonnage to be dealt with in about 80 per cent of the time formerly required under steam operation, which means an effective increase in the capacity of the line due to electrification of 62.5 per cent.

Further economies effected by electric operation are those consequent on the abolition of coaling stations, water troughs and turntables, and the time and labor which these entail in the case of the steam engine.

The saving in fuel consumption rendered possible by the adoption of electric working is becoming increasingly important as the high price of coal suitable for steam locomotive work is more and more pronounced. Apart from less consumption of power in idle time the main fuel saving which can be effected by electric operation is due to the very much more efficient combustion of the fuel that can be obtained under the conditions of modern central power stations than by burning relatively small quantities of coal on individual engines. This saving in fuel is one of the greatest advantages to be obtained by electrification, and figures given for the Chicago, Milwaukee & St. Paul Ry. show that one unit of [illegible] energy delivered by the power company to the railway company's lines took the [illegible] of between 6 and 7 lb. of coal on steam locomotives. In up-to-date power stations one unit of electricity is produced with less than 2 lb. of coal.

Careful calculations in the case of the North Eastern Ry. show that as a result of electrification the weight of the low grade coal that would have to be burned in the modern electric power station from which energy would be taken for working the traffic electrically, would not be more than 40 per cent of the weight of high grade coal used on steam locomotives to do the same work. On this basis, if we take the North Eastern coal consumption in 1919 (921,480 tons) we find that if electric working were substituted for steam there would be a saving of about [illegible] tons per annum, and a further saving would be effected due to the fact that the low grade fuel would be substantially cheaper than the high-grade locomotive coal.

The author enumerates further advantages of electric operation, including the elimination of stand-by losses, saving in transport of fuel, regenerative braking and reduction in cost of repairs and maintenance. In support of the last claim he quotes figures given by Mr. Armstrong in America in 1920, and also gives the following comparison of costs which had been got out for the Newport and Shildon branch of the North Eastern Ry.

	Material £ s. d.	Wages £ s. d.	Shop expenses £ s. d.	Total £ s. d.	Miles run between repairs.	Cost per mile d.
Steam, freight, engine	267 9 11	455 15 [illegible]	[illegible]	1,0[illegible] 1 8	51,134	5.060
Steam freight [illegible]	533 16 2	434 0 [illegible]	[illegible]	1,293 6 [illegible]	56,210	5.522
Electric	98 9 9	258 5 1	[illegible] 13 5	5[illegible] 9 3	100,101	1.316

Water Power Development in Switzerland

Switzerland is now using her utmost endeavor to develop her immense resources in water power, which are officially estimated to contain a capacity of 4,000,000 H.P. According to the British Department of Overseas Trade, one-fourth of this energy is obtainable from the rivers, and the remainder from the lakes and streams in the mountains. At the beginning of 1921 a total of 171 works (of over 500 H.P.) had been erected, or were in process of erection, while 190 works (of over 1,000 H.P.) had received, or had applied for, the necessary authorization for construction. The following table supplies certain important data with regard to both groups:

	Works built or building (of over 500 H.P.)	Works (of over 1,000 H.P.)*
Number of works	171	190
Utilisable accumulation (in cubic meters)	417,790,070	2,467,681,000
Minimum energy (net)	388,959	1,352,550
Maximum energy (net)	1,587,770	4,527,100
Annual energy production in million kw. hrs.	352,186	10,986
Accumulation energy capacity in million kw. hrs.	315,030	1,877,339

*For which authorisation received or applied for.

Among the power stations already built, or building, are five with from 60,000 to 68,000 H.P.; one of 52,000; one of 48,600; three of 45,000; one of 12,000; one of 40,800; and ten of from 20,000 to 32,600; among the projected stations are 15 of from 60,000 to 200,000 and 11 more of 50,000 to 55,000 H.P. There are now 18 large (i. e., from 20,000 to 72,000 H.P.) power stations in operation, and the sole obstacle to the rapid execution of the bulk of the numerous schemes is the dearth of capital. At the present time about 26 per cent of the estimated water power resources of Switzerland have been turned to account. On Jan. 1, 1914, the power utilized was officially estimated at approximately 500,000 (or 12½ per cent); at the beginning of 1920 there were in course of construction eight works with a total capacity of 400,000 H.P.

Engineering Council for Australia. A conference of the Institute of Engineers (Australia), the Australian Chemical Institute, and the Australian Institute of Mining and Metallurgy has decided to form the "Federal Engineering Council, Australia," with headquarters at Sydney. Subject to the unanimous approval of all the constituent bodies other Federal institutions may be admitted to membership. The object is to consider and act upon all matters of common concern to the technical profession, and to coordinate the activities of all the bodies represented in regard to questions of national and general importance. The council is to have no jurisdiction over the internal affairs of any constituent body, but its decisions upon matters referred to it by the whole of the constituent bodies are to be adopted by all of them.—Times Engineering Supplement, London.

Repairing Viaduct and Canal in France With Cement Gun

The repairing of a long masonry bridge of the Paris-Orleans Ry. at La Bouzanne in the center of France, by the cement gun method, involved interesting features, some of which are shown in the accompanying illustrations. Some portions of the arches were badly disintegrated. The mortar had worked out and the limestone had been damaged by the frost. Some holes had a width of 3 ft. and a depth of 14 in. to 16 in. One gun was used on the repair work. Air was furnished by an 8 by 8 in. compressor, driven by a gasoline engine which was placed at one end of the viaduct. The water was delivered under compressed air pressure from a tank. An interesting feature of the work was the use of a rolling scaffold which had sufficient clearance to allow trains to pass under it on the tracks. A platform supported by the scaffold permitted the workmen to reach all the parts of the arches. A reinforcement was put in the deeper holes; ½ in. round bars were placed in holes drilled with a jackhammer and supported an additional reinforcement according to the needs.

Rolling Scaffold Used in Cement Gun Work on La Bouzanne Viaduct.

The other illustrations show a cement gun outfit on barge canal work under the direction of the Service des Ponts & Chaussees. This outfit was used for repairing stone walls, old lock walls, etc.

The Revised British Standard Steel Beam and Channel Sections

From the Engineering Review.

The mathematical properties of the Revised Standard Beam and Channel Sections have now been published by the British Engineering Standards Association, and copies are obtainable at 1 shilling net, the publishers being Crosby Lockwood & Son, of Stationers' Hall Court, London.

One of the striking features of the new list, and one, we think, that will be of great value in extending the use of British structural sections for foreign markets, is the inclusion of tables showing the metric equivalents for the dimensions and properties of all the sections.

As we have previously indicated, the beams have been divided into two branches—girder sections and heavy beams and pillars; and American practice has been followed to the extent of employing regular increments in weights per foot.

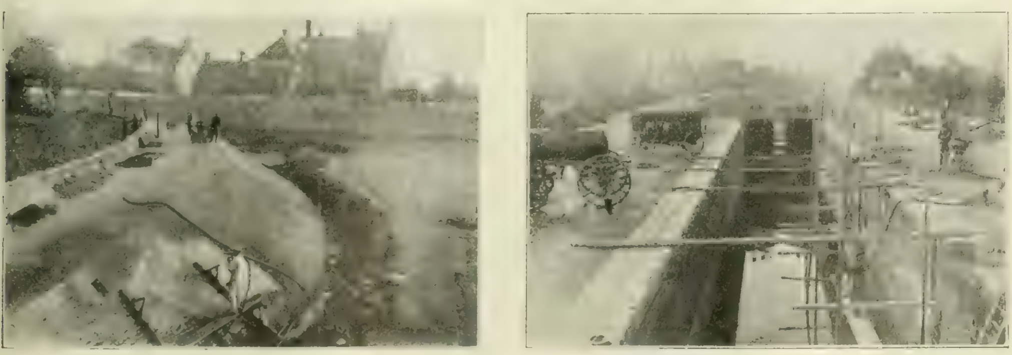
It may be interesting to see to what extent the simple rule for approximate modulus of section is true for the new girder sections; the rule is multiply the depth in inches by weight in pounds per foot and divide by ten to get the section modulus. We then obtain the following figures:

Section.	Approx. modulus	True modulus
3 × 1½ × 4 lb.	1.20	1.11
4 × 1¾ × 5 lb.	2.00	1.83
4½ × 2 × 7 lb.	3.15	2.96
5 × 2½ × 9 lb.	4.50	4.36
6 × 3 × 12 lb.	7.20	7.0
7 × 3½ × 15 lb.	10.5	10.[illegible]
8 × 4 × 18 lb.	14.4	13.9
9 × 4 × 21 lb.	18.9	18.0
10 × 4½ × 25 lb.	25.0	24.7
12 × 5 × 30 lb.	36.0	34.5
13 × 5 × 35 lb.	45.5	43.6
14 × 5½ × 40 lb.	56.0	52.[illegible]
15 × 6 × 45 lb.	67.5	65.6
16 × 6 × 50 lb.	80.0	77.3
18 × 6 × 55 lb.	99.0	92.5

From this it is clear that on occasions when one has not access to the tables the approximate rule is sufficiently accurate for most purposes.

We may compare the relative efficiencies of beam sections of the same depth by finding the section modulus per unit of area; as, however, the area is proportional to the weight per foot and the section modulus bears approximately the same relation as formerly to the weight per foot for the same depth, we shall not expect to find much difference in the efficiencies.

One feature of the tabulated values of properties upon which comment may be made, is that some of them are given to seven significant figures; this is a degree of accuracy that it is impossible to work to in practice and is almost absurd in view of the rolling margin allowed by the specification.



Repairing Walls of Canal in France With Cement Gun Outfit.

Bridge Impact Tests and Allowances.

By HARRY JOHN [illegible]

[illegible]

It is proposed to give here some suggestions for recording tests which may be made in the future, in order to obtain, if possible, a new formula for impact effect, rather than to treat of those tests already made in this and other countries.

The stresses to be noted in a bridge are those produced by:

1. Static dead load.
2. Elastic deformation of the material under dead load.
3. Static live load.
4. Elastic deformation of the material under static and dynamic live loads.
5. Rapid application of the live load.
6. Vibrations of the structure as a whole and those of its members produced by unbalanced locomotive drivers.
7. Shock caused by defective track and rolling stock.
8. Wind.
9. Friction of bearings.
10. Changes of temperature.

There is no difficulty in recording the algebraic sum of the stresses in a member of a bridge produced during any instant of time by a live load. Dead load stresses in existing bridges cannot, of course, be recorded, but those in new bridges can be recorded during erection, and it would be advisable to do so in future for important bridges, more particularly for those of the cantilever type.

In the subject under discussion it is only the stresses produced by the application of the live load with which we are concerned, but deformation stresses produced by live load must also be taken into account in drawing up a complete set of rules for guidance in design. If a sufficiently large number of records be taken on an old bridge under the usual traffic, the stress per square inch in any part is obtainable.

Course That Can Be Followed in Taking Stress Records.—When taking stress records for the determination of impact effect for use in rules applicable to the design of new work one of two courses can usually be followed.

The first is to take a very large number of stress records in many of those parts of a large number of typical bridges, where the present knowledge of the subject leads us to expect the maximum stresses per square inch, including deformation stresses, employing typical locomotives at various speeds, from a crawl to the maximum speed permissible. From the records obtained the results can be plotted against loaded length and be included in two curves whose ordinates will represent respectively (1) the maximum stresses per square inch produced by the static live load for any loaded length, (2) the corresponding maximum stresses per square inch produced by the dynamic live load at the highest permissible or the critical speeds. The difference in the height of the ordinates for any loaded length is a measure of impact effect.

From these two curves an empirical formula can be deduced which will give approximately the maximum permissible allowance for impact effect in the design of new work. It is obvious, however, that this formula can apply correctly only to the particular types of bridges and locomotives used in taking the records, and while much information regarding the laws governing impact effects would be obtained during the necessary runs [illegible] [illegible] of the records [illegible] [illegible] permits [illegible] to complete [illegible] is not [illegible] [illegible].

It is necessary in measuring any two comparable ordinates in the two curves above referred to, that the points thereon should have been produced by the same position of the locomotive on the bridge. In taking the static live load stresses the time would be shortened if the so-called "static" were about 5 m.p.h., as at this and even higher speeds there is no appreciable impact effect. This method of dealing with impact effect is essentially practical and useful, and a formula produced by it will probably be the one in general use for some time until a more scientific one is evolved.

The other course to follow is the more scientific one, and consists of a much fuller analysis of records in order to trace to their origin the many minor curves, which when added together algebraically by the stress recorders, form the curve given on an ordinary stress record, and from an analysis of these minor curves to obtain the laws governing their production. Many records are very complicated, and it would be almost impossible to analyze them. It, therefore, becomes necessary to obtain records in which some of the minor curves are eliminated and to obtain other records where vibration curves only without stresses are recorded, so that the shape and frequency of the curves can be more accurately determined.

Effect of Unbalanced Condition of Locomotive Drive Wheels.—Very many stress records of bridge members have been obtained in different countries by the use of various types of instruments and the experience gained from them is of inestimable value, and should of course, be used in making further tests. From the investigation of such records it has been determined and is now accepted by engineers generally, that it is the unbalanced condition of the locomotive driving-wheels which produces the greatest proportion of impact effect. The laws governing this effect have not yet been definitely formulated and much further knowledge is necessary, which can be obtained only by further tests.

It is desirable in such tests that the position of the cranks of the locomotive driving-wheels should be in some predetermined position on the bridge, but this is almost impossible to obtain in practice, and many runs may have to be made with the test train before the required position is hit upon by chance, and it is obvious that neither of the driving-cranks may reach its lowest position on a span whose length is less than three-quarters the circumference of the driving wheel. Where, however, a bridge is composed of a series of short spans, or where a span has a series of rail-bearers, the instruments up to the number available might be attached each in a similar position on all the spans or rail-bearers, and the exact positions of the crank recorded by a mark made automatically on each of the records, so as to obtain from at least one of them a record of maximum effect. From such a series of records much valuable information would be obtained, and it may be possible from them to determine the law. If not, then other tests of an even more scientific nature may have to be undertaken. While obtaining this law, of which one factor is the unbalanced condition of the locomotive driving wheels, it would be advisable and, indeed, necessary to obtain another factor for the lateral oscillation of the locomotive producing vibrations of the structure in a lateral direction.

The author does not at present see any way of easily separating from the records the stresses produced in the bridge by the lateral oscillation of the locomotive, but their relative value for different types of locomotive might be obtained by using a seismograph (or by temporarily converting the stress recorder into one for the purpose), by which means vibrations would be recorded instead of stresses.

To reduce the number of engine runs, deflection of the main girders should be taken under the static loads by a deflectometer, and from the record of such deflection the approximate critical speed should be calculated, and checked from the records.

The determination of a law for governing the effect of the sudden application of a rolling load to a bridge can probably be best determined by using a rolling load in which there are no reciprocating parts or in which they are balanced. A series of tests made with an electric train or with a four-cylinder locomotive over a series of bridges with a perfectly straight and even track, would go very far to establish the law. The stresses produced by the sudden application of the load are, however, very small. In conducting these tests the camber of the track on the bridge should be noted.

Recording Instrument Essential.—For carrying out such tests on bridges as here proposed a recording instrument is necessarily essential and the records of the stresses obtained should be of a permanent character. Moreover, the instrument must be of a stouter make than a laboratory instrument in order to withstand the shocks and vibrations to which bridge work is subjected by the passage of a high speed train.

The records should show a base line, the length and division of which should be a measure of time and consequently also a measure of train speed; and the recording line should show every vibration of stress, however caused, including the more rapid vibrations of minor parts of a bridge. The sets of instruments, including the deflectometer, should all be capable of being synchronized, so that the records can all be automatically and instantaneously marked at least with the exact time when the leading axle begins to effect the stresses in a bridge, and also when the last one ceases to do so. The lowest position of the driving wheel cranks should also be permanently and automatically recorded on the record.

The synchronization is very important because of the facility and celerity with which the records from the instruments can then be compared, and the actual speed of the train ascertained. In fact, the instruments should be such that they will record every vibration of stress while a locomotive is traveling over, say, a 5 ft. span or a rail-bearer, at 80 miles per hour (occupying less than one second of time).

Selection of Position for the Instruments.—The selection of the positions for the instruments is important, because, whatever movement under a train load occurs in a member of a bridge, to which an instrument is attached, that movement has to be conveyed to the instrument through the points of attachment, and its amount varies very greatly in similar parts of the same span.

The records obtained should be accompanied by very full data of particulars concerning the bridge, the locomotive, the position of the instrument, the condition of the bearings, and where roller bearings are used, the position of the fixed end.

It would be unwise to predict the exact nature of a scientific formula for impact effect, but it will probably contain coefficients for type of bridge and of locomotives and one for the central deflection of the bridge under unit load, and may contain one for maximum speed.

It is sometimes advanced by engineers that little is to be gained by further investigation of impact effect, on the grounds that a variation of, say, 10 per cent. above or below the Pencoyd formula is insignificant compared with the total of dead and live combined with impact as given by that formula; but this attitude is untenable in a scientific age, and it is quite certain that if it were possible to calculate the maximum stresses which are likely to occur in any part of a new bridge, it would be permissible to stress the material in such a bridge to a much higher degree than is considered, with our present knowledge, to be desirable, thus resulting in an appreciable saving of material.

Relation of Iron Bacteria to Incrustation of Water Pipes.

From The Surveyor, London

Before the Engineering Section of the British Association meeting at Edinburgh, Dr. David Ellis read a paper on the subject of Iron Bacteria in Relation to the Incrustation of Pipes, his remarks being illustrated by lantern slides.

Iron bacteria, said the reader of the paper, occur normally in water reservoirs, and predominate in the conduits of these reservoirs. They do no harm in the sense that they give rise to toxic products, but occasionally they multiply in an extraordinary manner and render the water unfit to drink. The problem of greatest interest to engineers in this connection, however, lies in the gradual diminution in the bore of his pipes, to an extent which causes the flow of water to be sensibly diminished. Cases have been known in which the pipe has become completely blocked up. Under these circumstances the biologist can render services to the engineer, for it is his business to index organisms, to study their life histories and apply his results, if possible, to the elucidation of practical problems. He himself had been engaged for the past twelve years in studying iron bacteria from all parts of the world, and had embodied the results of his work in book form.

Conditions in Which Iron Bacteria Live.—The five species of iron bacteria with which the water engineer should be either directly or indirectly acquainted are Leptothrix ochracea, Gallionella ferruginea, Cladothrix dichotoma, Crenothrix polyspora, and spirophyllum ferruginium, all of which were found in this country.

Dealing with the physiology of iron bacteria, the author said that after its identification the next step is to deal with the conditions under which they live, so as to be able to combat at the source the evil results which are brought about by their multiplication. It is well known that the iron bacteria are saprophyrea, and as such require organic food for their nutriment. Therefore, the question for the engineer to determine is whether the water under his care contains enough organic matter to supply these needs. The amount of this organic matter should be determined by bacteriological, not chemical, analysis, on account of the greater delicacy of the former method of testing. Further, he must ascertain whether the mineral ingredients in the water are such as to favor the growth of iron bacteria. All organisms require mineral as well as organic constituents, but the nature of the minerals required varies considerably with different classes of organisms.

Another fact which has emerged from a study of the physiology of the iron bacteria is that acid waters are more favorable to the iron bacteria than alkaline waters in which the chief salts in solution are compounds of sodium and potassium, or soft siliceous waters such as are found, for example, in the Manchester water supply.

The third fact is one the importance of which has only lately been realized. It is that iron bacteria can, and do, multiply independently of the presence of iron. They are not iron bacteria in the sense that iron is a necessary part of their food, but if they do multiply in the presence of iron they are capable of furthering the oxidation of ferrous to ferric compounds. This, however, is an incidental, and not an essential, feature in their metabolism.

Problems Resulting from the Bacteria. With these three cardinal facts in mind, the author then examined the different factors which interfere with the free flow of water as it leaves a reservoir, and also with the growth of the iron bacteria in the reservoir itself. Practical problems center around four different kinds of growths. These were (1) slimy streamers, which appear on the walls and on the bottom if the water is shallow of storage reservoirs. They are also found as streamers attached to the internal surface of the conduit pipes; (2) Tubercular incrustations, which are nodular excrescences on the pipes, and when they become confluent they seriously interfere with the flow of water; (3) Iron incrustations on non-ferruginous surfaces—the walls themselves are not corroded in any way; and (4) spongey disease of cast-iron.

As to the first, slimy ferruginous streamers owe their existence entirely to the activities of iron bacteria and other organisms of a similar mode of life. Gallionella and spirophyllum are the organisms chiefly concerned in the formation of these streamers. Although the amount of iron in the water is roughly only one part in a million, the unceasing accumulation of small amounts ultimately ends in large quantities being collected in the streamers. The mucilaginous degeneration of the cell-walls of iron bacteria furnishes the matrix in which the liberated iron can collect. When this mass of organisms dies, their dead bodies furnish an additional amount of organic matter to serve as the basis for the organic supply of the next generation.

With regard to the second, the occurrence of ferruginous tubercules is very common. The familiar limpet-like structures on the inner surface of the iron pipe are too familiar to need description. The formation of these tubercules may, and does, take place in the complete absence of the iron bacteria or any other organisms. The biologist has to determine whether organisms influence the process when they are present. The formation of tubercules is dependent on the presence of CO_2 in the water. The influence of iron bacteria is thus accelerative rather than causative, inasmuch as they enrich the immediate neighborhood of a tubercule with CO_2, and thus accelerate a chemical process which would take place in any case, even if the iron bacteria were absent.

As to the third problem, the incrustations that form on monferruginous surfaces must obviously obtain their iron from the water, and are entirely due to iron bacteria.

Remedies—Discussing the remedies, it was stated that each water supply must be considered on its own merits. The removal of slimy streamers must be governed by our knowledge of the iron bacteria. It must first be ascertained that the organisms concerned are iron bacteria. If this is proved, it becomes the duty of the water engineer to remove, if possible, every factor which is favorable to the life of such bacteria. The most obvious method is, of course, the removal of organic matter from the water. If the organic matter can be removed or oxidized, there will be very little material upon which the iron bacteria can subsist. Acid waters are worse than those whose reaction is non-acid. The exact effect of various mineral salts on these organisms is not yet fully understood, but anything tending to reduce the acidity will also diminish the power of the bacteria to do harm. In the past attention has been concentrated on the iron content of the water, but it is now certain that the attention of the water engineer should be concentrated on the organic matter. By the removal of the organic matter a good part of the offending iron will also necessarily be removed. This is an additional reason for tackling the question of the organic matter.

There should, concluded the author, be periodical biological as well as chemical tests for water reservoirs. The following tests should be conducted periodically:

(1) The amount of organic matter as determined by the number of bacteria per cubic centimetre that the water can support.

(2) The acidity of the water.

(3) The organisms that are established in the reservoirs and conduits, and particularly the iron bacteria that are normally present in the conduits.

How the Pyramids Were Built.

By S. McPHERSON.

From The Quarry Managers' Journal

Broken Stone Roads in 3,000 B.C.—The first thing, I believe, that appealed to explorers in Egypt in their endeavors to find out how the Egyptians were able to quarry, dress, and build the huge Pyramids of Egypt, was the remains of the roads which were discovered. Naturally, roads capable of carrying the stones, weighing many tons, were an absolute necessity. "These roads are constructed originally very much as our roads are built today," says Dr. Fisher, of the University of Pennsylvania. "The right of way was levelled, and large stones were packed in. On top of these were placed layers of stones gradually diminishing in size, until the fine ground stone of the surface was placed. This was wetted and pounded, probably by hand, until the top presented a smooth surface." Apparently our old friend Macadam—was not the inventor of the broken stone road which we know by his name. At any rate, 5,000 years ago water bound metalled roads were in existence in Egypt.

How the Egyptians Quarried Their Stone.—At this time the Egyptians were working an alabaster quarry at El Amara, 11 miles from the banks of the Nile, and 200 miles from Memphis. The road from the quarry to the river bank was built over hills and dales, through valleys and gullies; and over this road the blocks of alabaster was transported to build elaborate palaces and public buildings. Sleds and man-power with ropes were the means of locomotion, the surface of the road being well watered all the time to make it slippery.

The quarrying of the stone was done by wooden wedges. So far as we know bronze was the metal of which chisels and drills were made with, and holes having been made in the stone the wooden wedges were driven in at frequent intervals. Soaking with water made them swell and split the stone.

The blocks of masonry were dressed by bronze chisels. The tempering of bronze for tools is one of the lost arts, I believe.

Arrived at the river bank, the blocks were transferred to barges and poled down the river; transferred again to sleds and hauled to the site of the building.

Erection Methods—Herodotus records that the great pyramids at Gizeh took forty years to build, and required the labor of 100,000 workmen. This is commonly believed to be an exaggeration, but in any case the labor required to construct this enormous mass of masonry, seeing that they only had the most primitive tools, must have been very great.

The method used for pulling the stones into position on the smaller buildings of Heliopolis was at least ingenious. Presumably, [illegible] plates of sand and [illegible] or rough rubble were used. These were erected against the outer face of the wall as the wall progressed. As a course was laid the temporary structure was built to the height of the top of the course, and the next course dragged up it to its place, and so on till the last course was laid. The final dressing to the faces of stones was given after they were built, the top course first, and the temporary structure dismantled course by course, as the stone [illegible] finished the dressing.

In the interior of the building where columns were used to support the roof, these, when they consisted of drums, were erected in the same way. When, however, they consisted of monoliths, a different method was employed. This is very clearly shown in the temple of Kephren and Mycerinus at Gizeh. These were built in connection with the second and third pyramids of the group of which the famous great pyramid is the largest and oldest in date. Here in the outer and inner halls, positions of the various piers were first marked out on the rock foundation. Then at each place a square shaft was cut with three sides vertical, the fourth side always on the side from which the stones were to be brought, being cut away to a long slope. The roughly squared blocks for the pillars were then dragged on sledges until their ends were over the shafts and in line with the slope. The outer end of the block was then lifted up with wedges and ropes until it was standing vertically in the hole. The slope not only made this labor easier, but made the stone rise into position without any serious jar, which might have fractured it. The shaft was then filled with stones and debris, over which the floor slabs of same finer material were laid.

Methods of Constructing the Pyramids.—On all temples the roofs, as well as the walls and floors, were of stone, and these slabs were placed in position before the false work was taken down. All reliefs and other decorations on the walls were done after the masonry was fully in position. In the construction of the great pyramid similar methods were used. Here the whole structure was solid masonry, with the exception of the small burial chambers in the center with the passages leading to them. The burial chamber, which was sometimes below the actual level of the rock surface, was constructed first. In the pyramids of the fourteenth dynasty this chamber was lined and roofed with fine masonry, and in order that this could be built a great square pit had first to be cut down to the proposed floor level of the chamber, and in this the complete room was built. The pit was then filled in around and above the walls and roof of the chamber with masonry. The passages were begun in the same way, and as they sloped upward through the masonry of the upper structure work on them was continued pari passu with the building of the pyramid. As pyramids had a height of from 200 ft. to [illegible] ft., the incline used for dragging up the blocks was built around the sides of the pyramid itself, spirally, as we might say. It has been suggested by a [illegible] architect that this slope was actually left in the masonry itself, and later filled in after the main mass was completed. Since the pyramids were all faced finally with finer stone, it appears that this casing was placed in position from the apex of the structure downward, and that as it was completed it concealed the incline, and a smoothly finished face was left behind as the masons worked their way down.

The Rocker Lifting Method. Still another method of lifting described by Dr. Fuller, and long known to Egyptologists, is the rocker device. One end of this was tilted down. By means of wedges and levers the block of stone to be lifted was transferred to this end. Levers were then inserted at the other end, which was pressed down by man power until the stone had been lifted as high as possible, when that end was blocked up. It is suggested that a false platform was built to take all or part of the weight of the stone, and it then became an easy matter to elevate the unloaded end of the rocker. Under the whole device was then constructed a false platform and the process of rocking upwards was repeated time and again until the desired height had been reached. While this process entailed an enormous amount of labor, that was a plentiful commodity in Egypt in her days of glory.

Methods of Protecting Reinforced Concrete From Marine Deterioration.

By FRANCIS ERNEST WENTWORTH-SHEILDS.

In Water and Water Engineering, London.

Our experience of reinforced concrete for maritime structures now extends over 20 years. During this period, we have learnt that this material is likely to be very useful to the harbor engineer. But there have been several failures, and we find that reinforced concrete is much more liable to deterioration in and near sea-water than elsewhere. It is of the greatest importance to study the causes of such deterioration and how it may be avoided.

Nature of Deterioration.—Failures in marine structures have been of four kinds:—

(1) The concrete has become softened owing to the chemical action of sea water on the Portland cement which it contains.

(2) The concrete has scaled off owing to the action of frost.

(3) The concrete has worn off owing to attrition by travelling shingle and stones.

(4) The concrete has split and cracked owing to the rusting of the enclosed steel and its consequent increase in volume.

The first three classes of failures are, of course, not limited to reinforced concrete; they are comparatively rare, the fourth being the most common type of failure.

Preventative Measures. (1) The subject of the softening action of sea water on Portland cement concrete has frequently been discussed in this institution and elsewhere, and the various means for its prevention are well known. Generally, it has been found that cement concrete of good quality can safely be used in salt water, provided that it is made highly impermeable.

(2) The scaling of concrete by frost is a serious matter in very cold climates. To prevent it, the concrete should be allowed to harden in air before exposing it to tidal action, and again it should be strong and impermeable.

(3) Where concrete is liable to be worn away by moving stones, it has been found desirable to use a tough aggregate with large stones, to make the concrete strong, and to let it harden in air before it is exposed in position. Even in these cases it is probable that impermeability is an important quality.

(4) Generally speaking, it has been found that the steel in reinforced concrete is well protected from rust provided that the concrete is of good quality. In maritime structures, however, there have been several cases where moisture and air have penetrated through good concrete to the steel, causing the latter to rust and swell, and to crack or burst off the concrete covering. Many precautions have been suggested to prevent this action, e.g., coating the steel rods with paint. Probably a better coating is neat Portland cement grout, as this does not decrease the bond strength, but it is liable to come off unless the rods are very carefully handled. It is important that overcrowding of steel should be avoided, and the use of flat steel stirrups or links which cause voids in the concrete, and which prevent it from properly surrounding the main bars, should be forbidden. The size of stones should be limited to, say, ¾ in. The thickness of the concrete cover is a matter of importance. In the early days a cover of 1 in. to 1½ in. was considered sufficient, but there is now a tendency to increase it to 2 in. or 2½ in. Working stresses should be kept low, and the structure as a whole should be stiff, especially where heavy live loads have to be supported. Care should be taken to prevent stray electric currents passing through the structure. But it would seem that the most important preventive is to make the concrete impermeable.

Permeability of Concrete. Probably the most effective way of preventing all kinds of deterioration is to make the concrete highly impermeable. To effect this many means have been suggested, but their relative importance is uncertain, and the matter requires further investigation. The concrete should be well mixed. Both stones and sand should be well graded, i.e., they should not be uniform in size, but varying from coarse to fine. Mr. Fuller's investigations in this subject are well worth studying.* Another important matter is the proportion of water used in mixing, which should be neither too great nor too small, as either excess tends to produce a porous concrete. It has been suggested that denser concretes can be made by the use of special cements, but the writer has seen no experiments which are conclusive on this point. Again, many substances are on the market for which it is claimed that if mixed with concrete or mortar, they greatly decrease its permeability. An elaborate investigation into a number of such substances was made by the American Bureau of Standards in 1911.† They rather tend to show that the addition of such substances was of little use in the case of rich mixtures, and that some of them decreased the strength of the concrete. Probably the best pore-filler is Portland cement itself. In other words, for maritime structures a rich mixture should be used. Proportions of 1 cement to 3½ aggregate are now commonly used, and a mixture of 1:1:2 has been recommended. Such a mixture may seem to be extravagant, but after all, the cost of the extra cement is but a small proportion of the whole cost, and the money is probably well spent. Another means of preservation is the coating of the outside of the concrete with some kind of impervious liquid. Experience has shown that fuel oil which has been spilt on the water and deposited on reinforced concrete, has proved to be an effective preservative. It has been found that paraffin wax, bituminous paint, tar, and various kinds of linseed oil paint, are more or less effective in preventing water from entering into the pores of concrete.

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*See "Concrete, Plain and Reinforced," by Taylor and Thompson (Chapman and Hall).

†See "Technologic Papers of the Bureau of Standards," No. [illegible], Government Printing Office, Washington.

Roads and Streets Monthly Issue

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Roads and Streets—1st Wednesday
(a) Roads (c) Street Cleaning
(b) Streets (d) [illegible] Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation (c) Quarries and Pits
(b) Management and Office System (d) Steam Railways Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings (d) Miscellaneous Structures
(b) Bridges (e) Properties of Materials
(c) Harbor Structures (f) Management and Office System

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The Automobile Accident Rate

Few advances of civilization come as unmixed blessings to mankind, and the automobile is not among the few. After it has been longer established among us many of the evils attendant upon its introduction and early use will be eliminated, or at least largely overcome. We have become so thoroughly used to the motor vehicle that we are apt to forget that we are after all, still in an early stage of the development of its use.

At present the auto is conspicuous as an aid to crime and vice, and as a producer of fatal and becrippling accidents. If we are wise we shall not curse the automobile for these things nor accept them as unavoidably inherent evils, any more than we curse the rubber shoe because it helps the sneak thief, the hotel as a place of assignation, or the railroad for its accidents. In their present forms and extent, the evils are primarily evidences of an immaturity which, unless we are sluggards, we shall actively strive to outgrow.

The accident list, which is really worse than it should be, is due almost entirely to some form of human carelessness—the craziness of intoxication, an amazing cold blooded indifference, or a still more amazing stupidity on the part of otherwise intelligent people. Who of us does not know people of good mind and high character who drive their machines as if they expected Divine Power to guard them and all in their path? How many of us, ourselves, drive thus? Of course it is not every accident which is the driver's fault; but neither is it to his credit that other accidents do not happen. Who of us has not cursed aloud or silently at some fool who has cut his corner or who has skidded so that only quick footwork has saved us?

However, human nature is not to be changed quickly, and no amount of exhortation will materially reduce recklessness. The sole remedy at present seems to lie in more rigid enforcement of law and severer penalties. These unquestionably will reach the indifferent, and if the penalty extends to the deprivation of license, it will serve the double purpose of removing a dangerous driver and warning others what to expect. Doubtless deprivation would react in some measure even on the Divine Power dependents, and at the very least it would in time remove a considerable number of them from the field.

Here are a few figures from the latest census report:

	1916	1918	1919	1920
Automobile deaths within the death registration area (including about 82 per cent of the population) of the U. S.	5,193	7,424	7,968	9,103
Automobile deaths per 100,000 population in registration area	7.3	9.1	9.4	10.4
Automobile deaths per				
100,000 population in Boston	[illegible]	11.6	[illegible]	11.8
100,000 population in Buffalo	11.8	18.2	13.6	20.4
100,000 population in Chicago	[illegible]	11.1	[illegible]	[illegible]
100,000 population in Cleveland	13.8	22.0	16.0	[illegible]
100,000 population in Los Angeles	[illegible]	16.9	[illegible]	24.1
100,000 population in Minneapolis	[illegible]	[illegible]	10.1	[illegible]
100,000 population in New York	[illegible]	[illegible]	11.0	[illegible]
100,000 population in San Francisco	[illegible]	[illegible]	[illegible]	15.2
Deaths per 100,000 population in the registration area				
All causes	[illegible]	[illegible]	[illegible]	
Typhoid fever	13.3	[illegible]	[illegible]	
Influenza	[illegible]	302.1	98.8	
Violent deaths (except suicides)	[illegible]	[illegible]	[illegible]	

These figures bring various reflections. In 1919, out of every 1,000 deaths in the United States more than 7 were caused by automobiles; of all violent deaths, except suicides, almost 12 per cent were due to autos; auto and typhoid deaths were practically equal, but the typhoid rate is steadily decreasing, while the auto rate is steadily increasing; autos caused almost 1/10 as many deaths as "flu," and 1919 was a bad year for that disease. In 1920 there were averages of 25 deaths per day in the registration area; 1.3 per day in Chicago; and 2.1 per day in New York. A majority of the accidents in cities appear to be to pedestrians, of whom the greater part are children. Only a part of these accidents are the fault of drivers—what part, we do not know.

A newspaper dispatch from Los Angeles on March 29 states that since January 1 of the present year, that city has had daily averages of 95 accidents, 0.6 persons killed and 17.7

[illegible]. In justice to Los Angeles, however, it must be noted that the percentage of residents owning cars is very high, that the number of non-resident tourist automobiles is greater than in any other city, and that if the number of tourists and visitors in Los Angeles were added to the resident population the death rate per 100,000 would be somewhat reduced.

Of course automobile accidents will never be entirely eliminated, but we believe that most people will agree that they should be greatly reduced and that more energetic measures should be taken to that end. An encouraging sign appears in the steady decrease in the number of deaths per car, as exhibited in the following figures given by the National Automobile Chamber of Commerce: 1914, 0.0025; 1915, 0.0021; 1916, [illegible]; 1917, 0.0019; 1918, 0.0016; 1919, 0.0013.

The Railway Department of a State Highway Commission

The Highway Commission of Wisconsin has established a Railway Department under the direction of Mr. M. W. Torkelson, former bridge engineer of the commission. The function of the new department as planned is to supervise and improve the crossings of railways and highways. It will undoubtedly result in a kind of attention to grade crossings and grade crossing eliminations not heretofore to be found.

Crossing problems are marked by two main phases—the economic and the ethical, or humanitarian phase. Every grade crossing involves some risk, but so does every piece of construction work, every trip by boat or train or auto, every step in a busy street—even life in the home—in short, every moment of human life. Problems in safety, then, of necessity treat of the reduction rather than the actual abolition of risk or danger, and unfortunately we have not the data for their scientific solution. Furthermore there is no measure of the value of life and limb.

The engineer on a safety problem, therefore, is handicapped by a lack of the most important data, and his decision must be arbitrary in proportion. Strength of character, reasonableness, and good judgment should in especial degree mark this engineer.

The economic problem of the crossing warrants little comment here, although it has many times been inadequately or incompletely treated. The value of a grade crossing elimination in doing away with traffic delays on either or both of the routes involved can be computed exactly for a present traffic, and for the future with the same accuracy as the value of any other long-lived improvement. The value in reducing probability of accident even may be estimated with some accuracy in certain cases, although this is not to be confused with the ethical phase of the problem, which involves values not to be measured by awards of damage claims.

Too often have crossing problems degenerated at their inception into contests of supposedly conflicting interests, and continued so until their settlement by court or compromise. Such an innovation as that made by the Wisconsin Highway Commission should go far toward bringing these problems to a carefully studied solution to the benefit of all parties.

Improve and Standardize Automobile Signals

Among the pressing needs of present day highway traffic are the standardization and improvement of signals and signs. We say this with full recognition of the marked and rapid improvement observable in signaling devices, but even the most enthusiastic producer of such devices will scarcely claim that every necessary device is perfected and available or that standardization is being attained rapidly.

A considerable variety of devices is needed, and their perfection may well be left in the hands of the manufacturers. The field is largely competitive and affords ample incentive for improvement—an incentive which would be still further advanced by a general standardization and an active policy for the establishment of needed signals.

The foregoing is not intended as a reference to road signals only, for the need of improvement and standardization of vehicle signals is, if anything, greater. Hand signals, a first and natural development, should long ago have been established by legislative enactments on a standard basis for the whole country. That there is an approach to uniformity among them is due to their being in part naturally suggested, and also to a worthy, but only partially successful, effort by certain private organizations. But a mere approach to uniformity leaves us very far from the standard which should exist for the benefit of the modern traveler.

Hand signals at their best are unsatisfactory. They are hard to observe, hard to give (practically impossible from a closed car), readily subject to imperfections and mistakes, and nearly useless at night. One wonders that some simple yet adequate system of mechanical signals whereby the driver in the car behind will be warned of the intentions of the driver ahead has been so slow of introduction.

The possibility of varied types of mechanical signals makes the establishment of a legalized standard system a practical necessity. Presumably each state would have to have its own law on this subject, and undoubtedly there would be difficulties in securing that uniformity which is so desirable. Nevertheless we believe that uniformity is possible and that ultimately it is inevitable.

We suggest that this subject deserves the attention of such national organizations as that of the State Highway Commissioners, State Highway Engineers, County Commissioners and County Engineers. Members of such organizations, more than any other class of people, would be likely to co-operate effectively in the interest of a benefit of this character. The time for such action is before different systems become established in different states, and we hope that some of this summer's sessions will bear the much needed fruit.

Suggested Training for Engineers for Highway Work

In a paper presented in the symposium on highway transportation held Jan. 20 by the American Society of Civil Engineers, Mr. Thomas H. MacDonald, Director, U. S. Bureau of Public Roads, estimated that the number of engineers employed by the state highway departments in 1918 totaled approximately 10,000. He stated that the construction program has practically doubled since then, but the number of engineers had not increased in the same proportion. He further stated that the closest estimates that could be made in 1919 indicated that not less than 1,000 to 1,200 new engineers would be required in the highway work each year. These men, he said, must be furnished by the engineering schools, and although there is a lack of employment at present, for engineers, generally, with the opening of the construction season, the road-building industry will be able to absorb and will need more than are available of those fitted to assist in producing the character of roads needed. As indicative of the training of men needed for the highway program, and the character of instruction which should be received in the colleges and universities, the following suggestions were given:

1. Human Relations: The ideals of public service; proper contacts with the public; and proper relations with the contractor.

2. Management: Laws—State and national; layout of plans; material supplies; transportation; estimates; contractors' obligations; and engineering and administrative reports.

3. Construction Proper: Design—Interpretation and relative values; specification interpretations, and workmanship.

4. Materials: Interpretation of laboratory tests; field tests; and soils.

5. Traffic management during construction.

6. Relative Values: Economics of highway transportation.

These suggestions are not to be interpreted as advocating the adoption in college and university courses of superficial specialized instruction, but the curriculum of the average engineering course should be and can be revised and broadened to give thorough training in some of the broad fundamentals of science, English, economics and ideals of public service, in addition to sound courses offered in the Junior and Senior years, which will fit men to enter highway work much better prepared than they are at present.

Need for Propaganda for Highway Improvements

To the Editor: The Spring of the year is the most opportune time to discuss the popular subjects of good roads and automobiles, and in this connection it is interesting to note the number of articles on road construction in its different phases, and on the relationship that the motor industry bears to the highway situation, that have been contributed recently to the newspapers by several qualified observers and authorities. It is a time of the year when automotive displays are much in evidence and these naturally prompt good roads discussions for the two subjects are very closely related.

In the decade just passed we have witnessed remarkable progress in the motor production industry and we have also noted the attempt on the part of the highway builders to keep pace with the growth of the motor transportation accomplishments. Although we have made wonderful progress in building of highways throughout the country, this undertaking suffers by comparison with the phenomenal strides which have been made in the production of automobiles. Many and serious obstacles have confronted the road building work, while hindrances have not been put in the path of the motor production industry in a marked degree. The automobile has been and will continue to be the chief stimulus for the highways movement, and in turn the highway will be the greatest economic asset to efficient motor transportation. We realize that the true success of the motor transportation, whether in the form of pleasure pursuits or for commercial purposes, is dependent on the hard, smooth road, or pavement of good alignment and low grade. More than anything else it is a realization of the extent to which the individual and the community are benefited that will spur the taxpayers of the country to shoulder heartily the present and future burdens for the building of good highways.

As a nation, as a state, a community or an individual we are more concerned with the economic side of the highway situation than was the case of an age gone by, when expansion of road systems was gradual and moderate and the taxation burdens easier to bear. The building of extensive highway systems with the prevailing mode of constructing the high cost road types should be a matter of vital concern to every taxpayer, for to him is accruing the benefits derived from them and in him is vested the power to say whether or not this work will go on in uninterrupted manner until we reach the goal of our endeavors. With the rapid expansion of the highways throughout the nation there has naturally developed heavy bonded indebtedness and surely these obligations of a national, state, or municipal nature are reflected in the tax impositions that we bear, as individuals. It is a time of national financial strain, the inclination is to tighten the purse strings everywhere and we cannot feel sure that the road budgets of the present and near future will be safe against the knife of "economy."

Those responsible for the furtherance of the highway building in the several states and the nation should be constantly on the watch for attacks that would in any way result in the curtailment of the road programs of the present and the near future, for this work must be continued without break for a long time to come.

It is human nature to abhor taxation for any purpose whatsoever and the natural abhorence to tax levy is increased when people fail to see some tangible gain coming to them. It is more often the rural sections of the country that lack the true spirit of the highways development and fail to interpret and understand the values derived from the well made road. A reflection of the antagonism that can arise against the movement for good roads is reflected in the specific case of the state of Michigan, where recently petitions emanating from the granges of the state call for the stoppage of the sale of the state securities, the proceeds of which shall be used for the highway work. There may be some local point to this which we cannot discern, but it no doubt is a drastic step and will be regretted if it takes effect. We may expect periodic attacks on a work that is of the magnitude of this national undertaking and we can feel sure that the large part of the assaults arise from ignorance of the situation. However, it is often difficult to hear the weak voice of logic and reason in the din of a popular howl of grievance. In a local or state roads issue it is customary for those responsible for the road policies of the state or community to stand ready with hard cost data and maintenance figures and other data to justify their stand, but between the tax payer and the road engineer, commissioner or economist, you will sense a big gap in the viewpoint of the discussion. It seems possible that we might bridge over this gap, in part anyway, by creating more interest in this all important work by the frequent issuance of suitable propaganda calling attention to some of the many economies that are affected with good highway systems and the potent influence these systems have on our daily lives. Herein lies an opportunity for highway departments, bureaus and road officials an opportunity bordering on duty to put forth continues and convincing matter, to sustain the taxpayer in his burden and create that "esprit de corps" which this nation should have behind this prodigious work.

With the press of the country as a mouthpiece for such propaganda, the number of earnest supporters for the highways movement throughout the nation will increase many fold.

We must not forget that there is one phase in the construction of highways that is particularly important to this class of construction, and that is the necessity of continuity of operation. Broken stretches of improved highways are a utility only in the manner which they serve some local use, but the real service rendered by a system of highways comes from affording unbroken transportation facilities to and from centers of commerce, production, population, etc. Moreover, from the standpoint of costs of materials and labor it is a sound time to construct; it is opportune from the view of the general unemployment situation; and it is an economic need to the county, state and nation, that should spur us to "carry on."

WM. J. DOUGHERTY,
Portland, Me. Highway Engineer.

New Method of Gravel Road Construction in Iowa

To the Editor: A letter written by Chas. H. Miller of Memphis, Tenn., published on page 192 of your issue of March 1, 1922, asks for more detailed information concerning our experience with gravel roads constructed in Iowa.

Not being familiar with Tennessee roads I am unable to predict as to whether or not our method would be satisfactory in that section. From Mr. Miller's letter, however, I assume that they are now using practically the same methods for constructing gravel roads that were in use here about four years ago. In changing to the new system of construction I encountered the same objections from local road officials that are advanced by Mr. Miller in his letter. These objectors, however, were turned to boosters as soon as they were able to observe the results obtained from our present method of construction.

Relative to binder I have had several tests made of material taken from the road after it had been constructed. These tests were taken from the top 2 in. of the road, the second 2 in. and the third 2 in. from the top. In practically all of these tests the top 2 in. shows from 9 to 20 per cent of binder. The percentage of binder in the center 2 in. varies from about 8 to 16 per cent, while the lower 2 in. contains from 20 to 40 per cent. These results are obtained from pit run gravel carrying from 1 to 5 per cent of binder in the bank. To my mind these tests show that it is not necessary to add additional binder when the material on which the road is being built will make a suitable binder.

These tests have further shown that on highways that were being constructed during wet weather there is no definite plane in the finished road between the gravel and the subgrade.

We at one time encountered the theory that it was necessary for the subgrade to have a crown in order that the water going through the gravel surface and encountering the crowned subgrade would run off. As a matter of fact water going through the gravel surface will not run off between the gravel and the subgrade because there is no definite plane for this action to take place. Any water that goes through the surface material will simply saturate the subgrade. It is true that we need 4 to 6 in. of crown in the finished surface. If this road is perfectly maintained there will not be enough water go through the surface to do harm to the subgrade.

It is true that our first layer of gravel when very thin in the center often becomes badly cut up, but this is dragged level and another layer brought in from the shoulders and we feel that the material in the first layer is still in the subgrade adding stability to the road as a whole. The second layer will never cut up as bad as the first and by the time the road has reached its final cross section we have a good gravel wearing surface.

We have found that we get a road with better wearing qualities when constructed with the minimum amount of crown. The reason for this is that automobiles going over the road are not continually throwing the material to the shoulders.

J. F. REYNOLDS.

District Engineer, Iowa State Highway Commission,
Storm Lake, Ia.

Concrete Road Construction in Canada

Climatic and Soil Conditions Outlined in Paper Presented at Recent Conference of County Road Superintendent and Engineers of Ontario

By L. A. PARDO,

Deputy Road Superintendent, Kent County, Ontario

My remarks are mostly applicable to the construction of concrete roads in suburban areas and particularly applicable to the conditions found in the county of Kent, where the soil is mostly a heavy plastic clay, the country very flat and the ground water level, which is controlled by the adjacent rivers and lakes, about 4 ft. from the surface.

Effect of Temperature Changes.—In a country where temperature varies over 100 degrees great stresses must be expected and the destructive work of this powerful agent is plainly observed not only in every piece of construction for which man is responsible but in our rugged mountains and even our rocky shores. If a concrete pavement is so constructed that it absorbs any appreciable amount of moisture, subsequent cold weather will cause sufficient expansion to loosen pebbles and minute particles at the surface. These are later whipped out of place by the wind or passing vehicles, thus providing greater facilities for this agent to carry on its work, which although comparatively slow, is very persistent and certain to produce holes of various sizes on the surface. It therefore seems that every effort should be made in the interest of permanency to produce at the surface a concrete that will absorb a minimum amount of moisture.

Importance of Good Drainage.—It is equally important, in the interest of a smooth surface that good drainage should be provided so as to reduce as much as possible the percentage of expansion in the ground, beneath the pavement and in the shoulders. Water expands 10 percent in freezing. Perfectly dry earth would not show any appreciable effect from frost at all, but such conditions cannot be found or expected, so that the rate of expansion in our coldest weather lies between zero and 10 percent and the nearer it approaches zero, the ideal condition, the less will be the disturbance in the foundation of the concrete road.

It has been observed that cracks occur usually when the frost is going out of the ground in spring and not during the period of freezing, or in other words, when the ground is contracting under the pavement. This would suggest to us that during the period of expansion which is usually gradual the expansion was downward or toward the sides, owing to the weight and great strength of the slabs. When the thawing process begins, subgrade and pavement, in obedience to the law of gravity, settle downward, and natural beams form in the subgrade on account of its varying compactness, producing cracks which open on the surface and admit more moisture if not properly repaired. Once this natural adjustment has been made future changes are usually slow to occur, provided the conditions with regard to the drainage and moisture are constant.

Subgrade Movement.—The explanation of this subgrade movement during the first twelve months and its comparative permanence thereafter requires some investigation. The majority of cracks that occur in the surface of pavements are due to foundation movements and not expansion within the concrete itself. I am of the opinion that a critical analysis of any subgrade for a depth of 4 or 5 ft. below the surface would reveal a great variation every few feet in compactness, density and porosity; consequently, when the action of frost begins, its intensity will vary in accordance with those conditions, producing a network of beams and these conditions obtain once the adjustment is made so long as conditions of drainage remain unchanged. It would seem then that a subgrade of uniform compactness is very essential and that can only be attained by breaking up the roadway to some depth below the proposed subgrade, level, disturbing as much as possible all natural arches and pockets formed through ages and earlier construction, and finally recompacting the same by proper rolling.

The climatic conditions of Canada are rather extreme and they present to the Canadian engineer and road builder problems not considered in many parts of the world. The moderate climate of the British Isles is conducive to successful good road construction and particularly their low cost of maintenance considering the amount of traffic. Again, the topography of the county is such as to permit excellent drainage.

Poor Drainage Responsible for Many Cracks.—Good drainage should be provided to the subgrade of any pavement in a locality where a freezing temperature obtains for any length of time sufficient to penetrate it. Some soils have natural drainage, and in some localities the natural ground water level is many feet below the surface and some soils are quite impervious, offering almost complete resistance to the transfer of water from the surface to points deeper down where it will not freeze. Some soils absorb a great amount of water and like our heavy clay, soils become spongy and plastic. Owing to the uniform support which the subgrade is intended to give to the concrete slab, surely we cannot afford to allow it to saturate and freeze—a process that would be most destructive. Almost all specifications for the construction of large engineering work require that foundations go below the frost and that concrete must not be deposited on frozen ground. In the construction of highways, we can eliminate the latter but we cannot go below the frost line for our foundation, consequently, our attention should be turned to some practical means of preventing the subgrade from freezing. How can it be done? It is my opinion that the subgrade must be dry, or as free as possible from moisture without which the action of freezing temperature is not much to be feared. The various methods of providing drainage are somewhat beyond the scope of this paper but it has been introduced to suggest how poor drainage, in co-operation with cold weather, may be held responsible for the majority of cracks and settled joints almost invariably found on our concrete roads.

It is difficult to prevent deterioration caused by expansion alone. Elastic joints are inserted at intervals of from 30 to 50 ft. in accordance with various specifications and practice but the fact that most damage to concrete surfaces on account of expansion occurs at the joints has led many cities and suburban districts in Canada and the United States to abandon their use, except when a joint is made at noon and at night or any other time when pouring operations cease for longer than thirty minutes. However, in a climate such as this it is difficult to believe that the joint is not of some use in saving the pavement from the destructive effect of expansion.

Advantages of Uniform Aggregate.—If we wish to obtain a smooth riding pavement we must pay some attention to the uniform quality of the aggregate, that is, so far as specific gravity, wear and toughness is concerned. It is generally admitted that a certain amount of separation unavoidably occurs when the batch is deposited although we talk preventing it in various ways. It is also a known fact that the softest rocks are the lightest and if sufficient agitation is provided during the finishing operations it is natural to expect that the materials will arrange themselves in the mass in accordance with their specific gravity, that is, with the softest on the surface and with the degree of hardness increasing towards the bottom. Such an arrangement of aggregate would favor absorption of water, aiding the action of frost and wear. Many gravel pits contain an aggregate in which there is a high percentage of stone that can be ground up with ease, this may be expected to cause uneven wear which in turn would increase impact from traffic and further destruction to the surface, giving a rough riding and rough appearing pavement.

The Use of Calcium Chloride in Concrete Highway Construction

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During the past year actual practice and laboratory experiments have demonstrated the value of calcium chloride in highway construction to such an extent that the Division of Highways of Illinois has not only allowed its usage to accelerate the setting of concrete in cold weather construction but is also advocating it as a simple and practical method of curing.

Laboratory investigations were conducted on a large scale; every known and advocated method having been tried out. Over 450 specimens were made and tested for transverse strength. In all of the experiments made the specimens treated with calcium chloride showed the best results. Several methods of applying this chemical were tried, with the result that the greatest strength was shown by the specimens, the bare surface of which was sprinkled with the granulated chemical in the proportion of 3 lb per square yard of surface. This method of curing brought greater strength to the specimens at the end of 14 days than did the wetted earth method at the end of 28 days.

It was thought that heavy rains might wash the calcium chloride from the pavements and thus destroy its usefulness when applied in this way. Accordingly, tests were made with specimens from which the granular chemical was washed off 12 hours after its application. The results of these tests seemed to prove conclusively that the beneficial effect of calcium chloride occurs chiefly within the first 24 hours of its stay on the concrete and that after that length of time does not aid curing to any appreciable extent. As in the usual course the chemical is applied to the pavement in from 8 to 16 hours after the concrete is finished, it would be an easy matter to protect it from rainfall for 24 hours if the weather looked threatening, or to make the second application in case the first was washed off.

Tables I and II show the results and methods used in a typical series of tests made by the Bureau of Tests. In this series the specimens were made and cured in green concrete forms in order to approximate as nearly as practicable the conditions surrounding actual pavement slabs.

The actual curing of concrete pavements with calcium chloride was tried in a few cases during the past construction season apparently with very favorable results. In one case 7 miles of pavement were cured by first covering the pavement with about an inch of earth and then sprinkling the earth covering with a rich solution of calcium chloride. The solution was applied at such a rate as to insure approximately 4 lb. of the chemical per square yard of surface. The earth covering was at that time presumed to be necessary to hold the solution on the surface of the road and to prevent loss in case of a heavy rain.

The solution for curing was taken from water barrels placed at specified intervals along certain portions of road the day before pouring the slab. When the road was finished the proper amount of calcium chloride solution was applied to the earth covered surface of the pavement by use of an ordinary sprinkling can. Inspection was frequently made and although the weather was hot and dry much of the time it was noted that the earth covering at all times was moist. This would leave to the conclusion that the slab was at least as well cured as by ordinary method of earth covering and sprinkling.

The data gathered indicate that the surface application of calcium chloride not only results in more rapid hardening but may also frequently be less costly than the usual methods. On the usual job one man can apply the chemical as rapidly as the road is constructed. This method is especially economical where central mixing plants are used as in such cases there would be no necessity for pipe lines. The early attainment of high strength makes it possible to open roads to traffic at an earlier date than usual without danger to the concrete.

Investigations bearing upon the effect of placing concrete at low temperatures indicated that under such conditions calcium chloride incorporated in the mix at the rate of from 2 to 3 per cent of the weight of cement produces the best results in hastening the setting process of the cement, in securing an earlier strength in the concrete, and in preventing injury to the pavements by the action of frost or freezing. Uniform distribution of the chemical may be secured by dissolving the material in the mixing water.

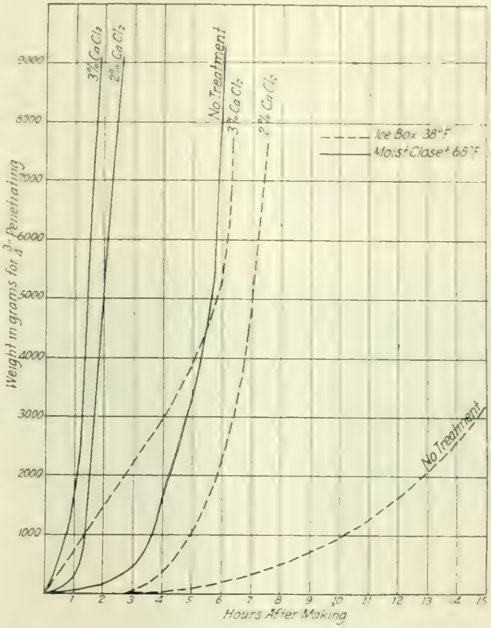

Fig. 1.

The laboratory experiments along this line consisted of

TABLE I.—TRANSVERSE STRENGTH IN POUNDS PER SQUARE INCH AT END OF 14 DAYS

Treatment.	Modulus of rupture average of 5 specimens
No treatment given. Specimens exposed to air .	776
Calcium chloride applied dry to surface, 3 pounds per square yard	952
Covered with 2 inches thick, wet for seven days	812
Calcium chloride, 3 pounds per square yard applied with dirt 1 inch thick	791*

*Calcium chloride applied in concentrated solution

TABLE II.—TRANSVERSE STRENGTH IN POUNDS PER SQUARE INCH AT END OF 28 DAYS

Treatment	Modulus of rupture average of 5 specimens
No treatment given. Specimens exposed to air .	736
Covered with dirt 2 inches thick, wet for 3 days .	785
Covered with dirt 2 inches thick, wet for 7 days . .	761
Covered with dirt 2 inches thick, wet for 14 days	768
Calcium chloride applied dry to surface, one pound to square yard	822
Calcium chloride, 1 pound to square yard applied with dirt 1 inch thick	794*
Calcium chloride, 3 pounds to square yard applied with dirt 1 inch thick . . .	802*
Covered with asphalt, ½ to ⅔ gallon per square yard	820
Calcium chloride applied dry, 3 pounds to square yard	907

*Calcium chloride applied in concentrated solution

TABLE III.—TENSILE STRENGTH OF STANDARD MORTAR BRIQUETTES
(Average taken of 3 specimens.)

	No treatment.		2% *Calcium chloride.		3% *Calcium chloride.	
	Tested at		Tested at		Tested at	
Storage.	2 days.	7 days	2 days.	7 days.	2 days.	7 days.
Damp closet Temp 68	175 lbs per sq. in.	320 lbs. per sq. in.	200 lbs per sq. in.	310 lbs. per sq. in.	208 lbs per sq. in.	310 lbs. per sq. in
Ice box Temp. 38°	33 lbs per sq. in.	142 lbs per sq. in	57 lbs. per sq. in.	206 lbs. per sq. in.	57 lbs per sq. in.	191 lbs per sq. in

*Calcium chloride dissolved in mixing water.

[illegible]—COMPRESSIVE STRENGTH AT END OF [illegible] DAYS

[illegible]

*Calcium [illegible] dissolved in mixing water.

making comparisons in strength and setting time of specimens containing variable amounts of calcium chloride. The specimens were made up in sets of six, three specimens of each set being placed in an ice box (temperature [illegible] deg. F.) while the other three were stored in a moist closet (temperature [illegible] deg. F.). At the end of two and seven days the specimens were tested for tensile strength and at the end of seven days were tested for compressive strength. The results of these tests are given in Table III and IV. Small truncated cones of neat cement were made up and stored in the same manner as the other specimens and were used in the penetration tests for determining the setting time. A uniform penetration was secured in every test through the use of varied weights on the penetration needle. The idea in using a fixed penetration was to eliminate errors which might be present due to early surface hardening. The penetration used in all cases was ¾ in. Figure 1 shows curves which illustrate the setting action of cement in relation to the weights causing the penetration.

Road Being Cured With Solution of Calcium Chloride and Dirt.

It is to be noted that in the laboratory tests for tensile and compressive strengh the specimens containing 2 per cent of calcium chloride showed higher strength than those containing 3 per cent of the material, while the specimens which contained the higher percentage reached a set earlier than the others. Though no tests were made on specimens containing 2½ per cent of calcium chloride, that amount would probably produce the best results in both strength and early setting time. Due to the variation in action of calcium chloride with different cements, it is thought that no fixed percentage should be advised for all cases.

For cold weather field work the chemical was purchased in granular form in steel drums and in 100 lb. bags. It was first dissolved in about equal parts of water and then added to the mixer drum before the mixer was charged with the batch. A sufficient amount of the chemical was added to each batch to insure a content of about 2 per cent by weight of the amount of cement. This method permitted the road to be finished much more satisfactorily and within a few hours after the mixer had shut down at the close of the day's work.

The granular calcium chloride was also used in a few instances on the subgrade to keep down the dust and to prevent freezing of the subgrade when a low temperature was expected. In these cases approximately 2 lb. per square yard were sprinkled on the subgrade.

Although the evidence collected indicates that calcium chloride incorporated in the mix may prevent concrete from being injured at moderately low temperatures, it was thought that freezing weather might damage the concrete and contractors were required to cover pavements with straw or earth during the extreme weather. In spite of the fact that calcium chloride may not safely protect concrete at all times, yet its use may frequently permit the closing of important work at the end of the season.

Automobiles Increased by More Than 1,000,000 During Past Year

With returns received from all states, the U. S. Bureau of Public Roads reports that the motor vehicle registration for the year 1921 totalled 10,448,632. This represents an increase of more than a million over the 1920 figures, or a number equal to the total number at the beginning of 1913. The greatest increases in registration were in industrial sections, the agricultural sections in general showing a smaller amount of increase. No state reported a registration less than the 1920 figures. The total amount collected as fees of various kinds amounted to $122,478,654. It has been expected that the registrations this year would show a greater falling off in the rate of increase than the figures reported show. The increase this year continues approximately the same average rate that has been maintained for the last seven years and shows no indication of the near approach of a condition of saturation in the supply of motor vehicles.

Concrete Paving Prices in Iowa.—Concrete paving prices at the beginning of 1922 were the lowest in Iowa in years, according to the January Service Bulletin of the Iowa State Highway Commission. At the Kossuth County letting ting on 11.25 miles of 18-ft. concrete pavement to be built from Algona, the county seat, east to Wesley near the Hancock County line, the job went for $2.59 per square yard. This is at the rate of $27,350 per mile. A primary road contract let Dec. 4, 1919, went at the rate of $3.59. The wartime peak price contract was for approximately 2 miles of concrete let on Feb. 16, 1921. This 2-mile contract for an 18-ft. roadway totaled $46,147 per mile. The contract for the last section of the Mason City-Clear Lake concrete road prior to the war, was let at $2.18 per square yard. This was at the rate of $23,020 for the 18-ft. road. The Mason City-Clear Lake road was for a 7-in. thickness of pavement and the Kossuth for an 8-in., with nearly double the amount of reinforcing steel.

Makes Automatic Tests of Road-Building Materials.—An experiment to determine just how hard rock or gravel must be in order to be satisfactory for use in building concrete roads is being carried on by the Bureau of Public Roads at the Arlington Experimental Farms of the United States Department of Agriculture. About 60 sections of experimental road are being constructed, in which practically every variety of stone, gravel and sand will be used. These sections will then be traveled over thousands of times by a machine automatically operated and which has the same effect on the pavement as a motor truck. This will continue until the wearing properties of all the sections are determined. The bureau believes that the results of these tests will show that many local materials heretofore deemed unsuitable may be used safely in building concrete roads, thereby saving the cost of importing stone, gravel, or sand from a distance.

Railway Department Formed by Wisconsin Highway Commission.—Through the formation of a Railway Department as an active branch of the Wisconsin State Highway Commission, definite recognition has been given to the necessity of careful planning in the relocation of highways and expert consideration of the question of eliminating grade crossings. M. W. Torkelson, former bridge engineer for the Wisconsin commission, has been placed at the head of the new Railway Department. His work will be chiefly connected with relocation of highways and elimination of grade crossings. The Wisconsin authorities are firmly convinced that many dangerous crossings can be eliminated by proper steps before expensive improvements are carried out, and that by careful relocation many of these crossings can be abolished altogether.

Cost of Labor Favorable to Road-Building Program.—Labor costs on Federal-aid projects under construction this year indicate that there will be no drawback along this line in the building of roads during the coming season, according to the U. S. Bureau of Public Roads. The price for common labor ranged around 25 and 30 ct. an hour in a great majority of the States, being somewhat lower in the Southern States and going up to nearly 50 ct. an hour in the Pacific States. The prices of teams reported were in a great many instances as low as the 1914 level. It is probable, however, that there will be an increase when the farming season begins, as teams have always been cheaper in winter.

Surface Treatment of Gravel Roads With Tar

Experiences of Maine State Highway Commission Described in Paper Presented at Annual Conference on Highway Engineering, at Ann Harbor, Mich.

By PAUL D. SARGENT,
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For the last 8 years the Maine State Highway Commission has been surface treating gravel roads with success. During that time we have used exclusively a refined tar product suitable for cold application.

The Early Treatment Method.—Naturally, we more or less followed in our early tar applications methods in vogue at that time. We attempted to get a true crown on our gravel roads by adding an inch or an inch and one-half of new gravel where necessary and then by the use of a drag or light grader truing up the surface before the application of the bituminous material. The first year this work was done on any scale we applied our bituminous material in two applications. In May we used about 0.4 gal. to the square yard and about the first of August retreated all of these surfaces with an additional 0.2 gal. per square yard. Treatment was laid only 10 ft. wide. The real thing we sought to do with this treatment was to bond the loose surface material to the tightly bonded surface below it, and we fairly well accomplished this result.

By the end of the season, however, we observed that on certain sections of our roads so treated there was a slight rippling and waving of the surface. It occurred to us that this might be on account of the fact that we had not secured an effective bond between the loose surface particles of the road and the tightly bonded gravel beneath. In other words, the material which had been impregnated with tar had laid more or less as a mat upon the surface, and not being sufficiently filled with mineral aggregate had pushed.

We had obtained, however, a much more satisfactory surface, generally speaking, than we had ever before seen on any surface treated road. The good sections presented the appearance of a first-class bituminous macadam surface, tightly sealed, smooth and dustless. As might have been expected, the edges of the bituminous treated section sheered off and crumbled away on account of so much traffic turning out for meeting and passing.

The Next Development.—Our next development was an attempt to clean the gravel surfaces before the application of the tar. This was accomplished by the use of graders and drags and later by using a street sweeper and finally by following that with hand sweeping. We also increased the width of our treatments to 15 ft. We found that all of these steps gave us a much improved surface and, in fact, since the first year we have used tar we have never made but one application to any gravel surface during a season. No sand covering was used during our first two or three years of treatment. The tar was applied on warm, dry days from an automobile tank distributer under pressure, and we just allowed the tar to lie on the road until it was absorbed and took its set.

Needless to say, we had much complaint from the traveling public on account of the dangerous condition of a freshly tarred surface for rubber-tired traffic. We attempted to obviate this danger as far as possible by treating one side of the road at a time. We would do a considerable stretch of road, anywhere from 6 to 10 miles long, and treat it on one side only. While the treatment was being put on the first side the other half of the road was left open for traffic and by the time we had the first half finished the tar that had been first laid was well enough set so that traffic could go on it. Then the other half of the road would be treated in the same way.

We observed, of course, that steel-tired traffic wherever it ran on the freshly tarred surface stripped the bituminous material from the surface. This made it necessary to do more or less patching by hand. Also, on account of the increasing automobile traffic, which was continually getting on to the freshly tarred surface, we found it necessary to sand the tarred surface a few hours after application.

For the last three of four years we have made a practice of treating all of our surfaces 18 ft. in width, which has practically obviated the necessity of any patching on the shoulders or edges of the treated surface. Eighteen feet in width, which, by the way, is our standard width of pavements and hard surfaces today, affords a good double track way. We have been following the practice during the last three or four years of immediately covering the bituminous material with a light application of sand. By immediately, I mean that within 5 or 10 minutes after the distributor has delivered tar to the surface of the road it has been covered with sand.

Points Regarding Application of Sand.—There are one or two points about sanding that I think should be spoken of. We place the sanding gang at intervals of 150 to 200 ft. apart, according to the length of road that the tank of tar will cover. Immediately the tar tank has passed, these men begin to sand and the sanding is started at the center of the road and first a place is made where passing vehicles may turn out on the freshly tarred surface. This affords traffic meeting places at stated intervals, so that with careful driving it is not necessary for a vehicle to become smeared or spattered with tar or to take the risk of skidding incident to driving on a freshly tarred surface. Our sanders are also instructed to keep an eye to the traffic so in case anyone gets into difficulty we will have some witness as to what actually happened. These men also more or less caution drivers to be careful. Where we are applying tar over a summit grade we always plan to have a sander stationed at the summit to keep an eye to passing vehicles and to warn them against collision. These are points we have learned from experience and we have found them to pay. I offer the suggestions for what they are worth.

Present Standard Practice.—I might say that in general we have developed the following standard practice: As early as we can get on the roads in the spring, that is, when the roads begin to settle and dry out after the frost has left them, we begin shaping with the road grader. The roads are carefully watched during the two or three weeks while they are settling and are shaped either with a drag or blade grader several times if necessary to have them settle with as true a contour as possible. The next step in our surface treatment is to draw out sand, which is left on the shoulder of the road in piles of about ¼ yd. every 25 feet. Generally speaking, we use about 50 yd. of sand to a mile of cover. We use less sand, however, on a brand new treatment than we do on retreatment. Sometimes as little as 30 yd. to a mile is used on the original treatment. Retreatments will take from 40 to 50 yd. per mile, as the tar has less opportunity to penetrate into the surface of the road. The next step is to clean the surface of the road of all loose materials. If a pocket of sand, dust or stone is left on the surface we are absolutely sure to have the treatment break over that pocket in a short time after application. This cleaning is done by the use of a street sweeper behind a light truck and if further cleaning is necessary after the sweeper has finished this is done by men with push-brooms. Then comes the tar distributing gang, which is equipped with Kinney pressure distributers mounted on 3½-ton trucks. We have limited ourselves to this size of equipment because it is as heavy as our roads, generally speaking, will carry. We have a law which limits the gross weight of load to 9 tons, and I am free to say that one of these 600-gal. tanks filled with bituminous material will a little exceed the limit set up by statute for the gross weight of load. Under average conditions one tank truck will spread about 2,500 gal. of tar per day.

We still hold to the practice of tarring one side of the road at a time and several days may elapse between the tarring of the first side and the tarring of the remainder of the road. As pointed out above, immediately after the tar is applied a light sanding is given. We put on just enough sand to fairly blot the bituminous material and keep it from running off the crown of the road to the edge. The surface is carefully watched for three or four days, and if evidence of bleeding shows up spots where this occurs are treated with more sand. Sometimes after a treatment has been down for two or three weeks an extremely hot day will start a little bleeding. This is watched carefully by the patrolman and the same treatment of light sanding given.

In the treatment of new gravel surfaces, that is, surfaces which have never received a treatment before but which may have taken traffic anywhere from two to four or five years with an occasional resurfacing of gravel, we use not to exceed 1/2 gal. per square yard, and in more cases probably use 0.4 to 0.45 gal. per square yard for the treatment. The amount of material depends upon the tightness of the surface. We have found that the smallest quantity of material we can use and get the surface covered gives us the best result. With a small quantity we never have trouble from rippling or waving of the surface, provided the gravel is in proper shape to receive the treatment when it is given, that is thoroughly bonded and tight with no pockets of loose gravel, dust or other material. We also find that surfaces which have received a small quantity of tar can be re-treated for a longer time than surfaces which have been given a heavier treatment. Those which have received the heavier treatment will ripple and get out of shape, say in two or three or four years, while sections receiving a light treatment can be maintained without breaking up for a considerably longer time.

It must be borne in mind that the addition of the bituminous surface treatment to a gravel road does nothing but preserve the surface against disintegration from passing traffic. It does not materially strengthen the road in the sense that it will cause the road to carry heavier loads than the gravel surface itself or the foundation upon which it is laid will sustain. Surface treatment will not supply or take the place of drainage.

Maintenance of Surface Treated Sections. Our surface treated sections are kept under constant patrol maintenance. We patrol these roads with a light truck and two men and they are assigned sections anywhere from 12 to 18 miles long. Besides watching the bituminous surface and mending any small breaks that may occur (and we have these breaks occasionally) and patching the shoulders, these men also keep the dirt shoulders shaped by dragging, keep the gutters and culverts clear, and do whatever other work is necessary. We supply about 3 bbl. of bituminous material like that with which the road is treated for each mile of surface. This material is mixed with sand and kept in stock piles. The mixing is usually done by hand, and we use about 17 gal. of tar to cu. yd. of sand. In a few instances we have used a small concrete mixer to prepare the tar and sand for patching and we have been able to use as little as 14 gal. to a yard of sand when the mixing is done in a concrete mixer. Patches are made by simply cleaning out the hole, throwing in the mixture if bituminous material and sand and patting it in with a shovel. Any bad breaks on the shoulders are repaired the same way.

Condition of Gravel Treated Surfaces in Spring.—The most of our gravel treated surfaces do not remain intact over the spring period, a good deal of it breaks up. This is due to several causes. An open winter which allows the frost to penetrate deeply into the roadbed and allows traffic to run all winter long, or heavy traffic coming on these surfaces when the frost is leaving and the surfaces are soft will break up and generally disintegrate the surfaces. This really is more or less of an advantage, because if obviates the necessity of breaking up these surfaces and we save just that much expense in getting the surface ready for subsequent treatments. I have in mind one section of gravel road which was surface treated during the summer of 1920. Most everyone called it a good section of road; in fact, many automobilists have referred to it as bituminous macadam and many of our citizens refer to our surface treated gravel roads as bituminous macadam roads, especially when they want to tell about a bituminous road the Highway Commission has built which has failed in the winter. The particular section I refer to was so bad during March, 1921, that automobiles could not pass over it, or through it. For 4 or 5 miles this piece of road was literally a sea of mud for a period of about three weeks. Of course the surface treatment completely disappeared. We reshaped the road as it dried out and re-treated it last spring. It presented a good surface all through the summer and fall until it was covered with snow. I apprehend that the coming spring will be a repetition of the spring of 1921. The road will be in about as bad condition as it was then but by June 15 it will look like a boulevard.

On the other hand, I have in mind one section of surface treated gravel road which is built on a sandy foundation where the drainage is perfect that has never broken up during the last 8 years. It gets a re-treatment about every other year, maybe 1/6 or 1/7 gal., as the gang goes by, and during the intervening year it does not get treated. This particular section shows evidence of slight ripples. It is on our heaviest traveled line, where the snow leaves earliest in the spring and we have the most severe truck traffic in the State.

We have a good many sections of surface treated gravel roads which do not break up in the spring. The most of these sections get a re-treatment each year. The second year the amount of tar which we have used has been from 0.3 to 1/3 of a gal. per square yard. For the third and fourth years the amount has run as light as 1/4 gal. and in some instances 0.2. These surfaces are quite apt, however, after three or four re-treatments, to become ripply enough so as to be uncomfortable to ride over. This condition is due to a combination of reasons. One is that we may have as much as 1-1/2 or 2 in. of tar penetration which becomes separated from the gravel road itself on account of the passage of heavy loads when the frost is coming out of the roads and the whole roadbed is more or less soft.

Method of Treatment for Wavy Surfaces.—Where this tendency exists at all it is always more pronounced where the surface has received successive treatments than where only one or two treatments have been given. Each year we have to break up more or less of this kind of surface and get the road in shape for new treatment. The method used is about as follows: We take a section of road about 1,000 ft. long; it is broken up either by using a pressure scarifier on a steam roller or by using a heavy blade grader behind a truck or a roller and setting the blade so that it will do more of a plowing operation than a scraping one. The bituminous surface is in this way broken up into junks anywhere from 2 in. to 2 or 3 ft. square. We next take a road grader and scrape this whole surface off to the shoulder of the road, then we plane the roadbed below to as true a surface longitudinally and transversely as possible. We then work back a portion of the bituminous bound material from the shoulder, distributing it over the surface. In this distributing operation the bituminous bound gravel is broken up more or less into small chunks. We then leave the road for two or three days for traffic, which materially helps in further breaking up these pieces of bituminous bound gravel, then the road grader is brought on and further working of the surface is given just by pushing the junks around and pulling in more from the sides. By watching the surface carefully and using the road grader every two or three days we have been able to get the surface back into reasonably smooth condition. It presents more or less of a mottled or mosaic appearance.

Gravel which has been covered with the bituminous material has lost its binding property and it is necessary quite often to add a bit of good binding material here and there to complete the bonding of the surface. This binding material is used sparingly. We do not intend to have enough to leave any appreciable amount of dust to be swept off prior to the new treatment. As soon as we have the surface in shape we plan to immediately give it a new application of tar. We find that one of these surfaces broken up and reshaped as just described is very hard to keep in true contour under traffic, and if it is allowed to go, say two weeks, we may have to break it up and rebond it before the tar surface treatment is given, else it would be so uneven as to be a bad riding road all through the season.

Experience has shown that one of these old tar surfaces can be scarified and broken up much more easily when the temperature is between 60 and 70° F. than during cooler weather. Good warm, sunny weather also materially assists in breaking up the junks of tarred gravel which are left on the surface of the road.

One thing we have satisfied ourselves upon is the fact that we cannot successfully apply tar surface treatment on a wet road or on a damp road. We have also had the experience of rain falling within two or three hours after tar has been applied and before the tar has taken any set, and with a traffic say of 100 to 200 cars per hour this has resulted in making a mushy surface which it is practically impossible to true up and make satisfactory. We have practically come to the conclusion that when this condition prevails we would do better to scrape the new tar surface right off on the shoulder, throw it away, reshape our road and put on a new application of tar. We will spend more money in patching the surface which is laid under these conditions than it would cost to replace the surface, and such surface after patching has never been satisfactory

Cost of Tar Application. During the last four years our surface treatment work, plus the cost of patrol maintenance, for a season of eight months, has averaged to cost $1,000 per mile. We estimate sand to cost us an average of $2.00 per cubic yard delivered in piles along side the road Tar costs us $0.12 in tank cars delivered on the nearest railroad siding. We figure the cost of applying the tar at $0.02 per gallon. Sanding costs about $0.75 per cubic yard of sand Using, say 4,000 gal of tar per mile gives us a cost for tar on the roadbed of $560; 50 yd. of sand will cost $100, applying the same $37.50, making the cost of the tar treatment covered with sand $697.50.

Cost of Shaping.—The average cost of shaping and getting the surface ready for treatment in the early spring would be about $25.00 per mile. We use ordinarily a 2-ton truck to draw the road machine. The truck rental would be $10 per day, the driver's pay $3.75 and a helper $3 The rental of the road grader is figured at $2 per day Gas and oil will run from $5 to $6 a day. This outfit will average to smooth four miles per day Usually on the first smoothing we make about four round trips per mile. On subsequent smoothings possibly two trips will do; it all depends upon the condition of the road when it is smoothed and the subsequent condition of rain and settling of the road

Cost of Sweeping.—For sweeping we use a mechanical sweeper drawn by a light truck, say a ¾-ton or a 1-ton truck. We usually make four round trips with the sweeper, and this outfit will sweep about two miles per day, as we can only run the sweeper about three miles per hour. The expense for sweeping would run about as follows:

	Per day
Truck rental	$5.00
Oil and gas	2.00
Driver	3.75
Helper	3.00
Rental of sweeper	2.00
Total	$15.75

On the basis of sweeping two miles per day this gives a cost of $7.87 per mile.

Cost of Patrol Work.—The balance of the $1,000 is paid for patrolling the road through the season. The usual patrol gang in bituminous surface-treated gravel roads is a patrolman with a 1-ton truck and helper. According to the amount of traffic and the condition of the road, this outfit will cover anywhere from 12 to 18 miles of road. The outfit costs $13.75 per day, made up as follows:

Rental of one-ton truck	$5.00
Gas and oil	2.00
Patrolman, who drives the truck	3.75
Helper	3.00

These gangs work an average of 200 days per year, so if the patrol section was 13¾ miles long the average cost per mile would be just $200.

Based on the figures given above, this would show a maintenance cost of $930.37 per mile. I have said that on new roads we use ½ gal. of tar per square yard. That will increase the cost $140 per mile over the figures already given.

Where it is necessary to scarify or break up the old bituminous surface, we run into a considerably larger expense for preparing the surface than indicated above. I think I have given enough explanation, however, to show that the average cost is very close to $1,000 per mile.

There is one point that I neglected to mention, and that is that quite often in making an original treatment if traffic is running fairly heavy and it will take us six or eight days to treat the section we are working upon, we will slide over the road with a priming coat of the tar material, using 0.2 to 0.25 gal. per square yard, the quantity depending upon the tightness of the surface. This will hold our surface in perfect condition under traffic for a week or ten days. We immediately apply the balance of the quantity, sand, and finish up the job. We have almost come to the conclusion that it would be good practice to do the priming everywhere on new surfaces. It gives a better penetration of the bituminous material, besides holding the surface in proper contour until the treatment can be completed.

Traffic on Surface-Treated Gravel Roads.—I ought to state before closing that we have many miles of surface-treated gravel roads which are carrying a 12-hour traffic, from 7 a. m. to 7 p. m., averaging from 2,300 to 3,500 vehicles per day for a week's time, with a maximum traffic during the 12-hour period of as high as 5,500. This traffic continues for a period of four to five months, from about the 20th of May until well toward the first of October.

We find it impossible to hold our gravel surfaces in satisfactory condition by ordinary patrol maintenance methods, that is, dragging and patching with gravel, when the traffic exceeds 500 to 600 vehicles per 12-hour day, and the expense of such maintenance runs about $500 per mile

The material which we use for surface treatment falls within the specification T C.—1, tar for cold application, Bulletin No. 691, U. S Department of Agriculture.

Credit for the most of the developments we have made in surface treatment of gravel roads is due to A. J Wiggin, Superintendent of Maintenance of the Maine State Highway Department.

A Method of Finishing Joints in Concrete Pavement

By E. E. BAUER.

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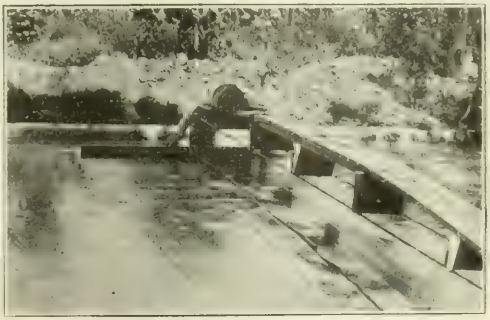
The securing of a smooth surface on a concrete slab ajacent to the transverse joint has been such a source of trouble that many engineers have eliminated the joint from their designs. The chief difficulty is that the concrete within a foot either side the joint is invariably piled too high and none of the operations of finishing succeed in bringing the surface down.


Finisher at Work on Joint with the Straight-Edge.

It is a common practice to test the joint before the concrete has set by touching a straight-edge to the surface at a number of points across the slab. This method will catch a number of the irregularities, yet it may also miss many high and low places in between the points where the straight-edge is used. Furthermore the concrete is soft and the straight-edge will sink in a small amount at various points, thus making it appear that the surface is all right.

It is quite generally agreed that the best way to secure a smooth surface is to use a templet moving longitudinally along the slab. At joint, however, we need a templet moving transversely across the slab to cut off the excess concrete.

This idea was carried out by the local contractors last summer and uniformly excellent results were secured.

The concrete for the slab is placed, shaped, rolled and belted once in the usual fashion. The straight-edge required by the specifications is then used as a templet or cutting tool. The finisher begins at the middle of the slab and works toward the gutters. He draws the straight-edge over the surface, giving it a slight longitudinal motion as he moves it transversely across the pavement. The finisher must hold the straight-edge so that the ends will just touch the surface established by the templet moving along the slab. This may seem a little hard at first, but a skilled workman will do it easily after one or two attempts

After the straight-edge has been used in this manner, the only work that should be done on the slab is to give it the final belting and run the edging tool along the joint.

Gravel Road Maintenance in Ontario County

Methods Employed by Canadian County, Described in Paper Presented March 2, at 20th Annual Meeting of Ontario Good Roads Association

By D. J. KEAN,
[illegible]

Two of the most important points to be considered in the construction or maintenance of a road are drainage and foundation. It does not matter whether the surface be earth, gravel macadam or concrete, its life depends on a stable foundation. The stability of the foundation depends on adequate drainage for a subsoil saturated with water cannot furnish a good foundation.

Drainage Methods.—To drain the surface of the roadways we give them sufficient crown to shed the water into the side ditches which are provided to carry the surface water to a free outlet. Under-drainage is used to lower the water level in the soil and keep it at a safe distance from the foundation and also to centralize the location and direction.

Under-drainage intercepts the flow of sub-surface water beneath the crest of the road. In this way the ground dries quickly in the Spring avoiding a soft and spongy road that would soon become a mass of mud. A road on a wet undrained bottom will always be troublesome and expensive to maintain, and when you consider the expense the municipalities having jurisdiction over these undrained sections of road are confronted with each Spring, and the inconvenience the traveling public are subjected to, tile under-drainage and proper side ditches are surely beneficial and economical. It is therefore economy in the long run to go to considerable expense in making the drainage of the sub-soil as perfect as possible.

Particular attention should be given to under-drainage at points 50 to 200 ft. or more down grade from the top of a hill, and particularly so if the roadway is in an excavation also a sidehill cut. Water will filter out to the surface at such points and the entire skill of the road builder will have to be exercised to prevent the road heaving and breaking up into a mire in spring time. In such cases put in ample tile, do not curtail the under-drainage, but care must be exercised to provide a proper grade and a good outlet for the tile, otherwise poor results will be obtained if the tile is indifferently laid. Sometimes a blind drain may be used to good advantage.

Side ditches and a proper crown are essential to all country roads, the object of the side ditches being to drain the water from the traveled roadway. The grade of the ditch should be such that the water is carried rapidly to a good outlet.

Surface drainage of the traveled portion of the road is accomplished by giving it a crown, the proper crown will vary with the nature of the roadway. For earth or gravel roads a usual crown is from ½ in. or 1 in. to a foot. It is not good policy to have too much of a crown, for then the traffic is concentrated in center whereas we wish to distribute the traffic over the whole of the traveled portion of the road.

Maintenance Methods.—When the gravel road requires dragging at frequent intervals, it may be due to the gravel becoming worn out, having very little metal left in it, at the same time being subjected to unusually heavy traffic or to extremes of wet or dry weather. It is good economy to spread a thin layer, according to the condition of road and traffic requirements, of fine pit or cementitious gravel over the surface and rolling it if a roller be available. If not the traffic will compact it by reason of the fineness of the materials and the thinness of the layer.

Two principles are involved in the use of the drag. The first is the length and position of the hitch, and the second is the position of the driver on the drag. For ordinary purposes fasten the clevis on the chain at such a point so that the drag extended will follow the team at an angle of 45 degrees. In this position the earth moves freely along the drag and the draft on the team is light, if the driver rides in the line of the draft.

Sometimes conditions are met with that require special treatment but for the most part road working with this implement is very simple. The object of such treatment is to move the material from the side toward the center of the roadway, to fill the holes and ruts and to raise the center gradually above the surface at the sides; there will generally be found considerable good material at sides of road which has been crowded out by traffic. This material if not dragged in toward the center of the road will soon accumulate and prevent water from escaping to ditches. The traffic then will solidify the fresh material in the ruts and holes.

Another implement by the use of which very satisfactory results can be obtained is the one-man-one-team grader. This in many cases is superior to the split-log or steel drag for leveling, but both implements serve a good purpose when in the hands of a competent operator.

When to Use the Drag.—The drag does its best work when the soil is moist but not sticky, the material then moves freely along the blade. If the roadway is badly rutted and full of holes, it is best to use the blade grader at least once. This is particularly true in the Spring just as the frost is going out. A smooth road surface is secured by this method.

Bring the road to a suitable grade and cross section and provide ample side ditches and if sub-surface drainage is required, put it in.

The gravel is dumped on the road in such quantity that it will spread to the thickness desired and then spread with shovels or by light blade grader, which saves time and money and does better work than by hand.

A thin layer, 3 to 5 in. thick, has proven economical. It quickly consolidates and gives smooth surface. A drag is very useful for maintaining the surface during this period and if the dragging is done carefully after the rains, a smooth even durable surface will result.

Pit gravel falls into four groups: (1) Ideal gravel, (2) too coarse, (3) too fine, (4) lacking in bonding material. The bonding property of gravel is due to clay, iron oxide, lime and the angular shape of gravel; the clay should not exceed 20 per cent. Gravel should be well graded from a size that will pass a 2-in. screen down to fine clay, no more than 80 per cent nor less than 60 per cent should pass a 1½-in. screen.

Rolling and Scarifying.—Good economical maintenance can be accomplished by using a scarifier and roller. The graveled portion of the road is scarified to a depth not to exceed 3 to 4 in. Even this depth will, on the ordinary country road, dig up considerable stones of a rounded shape. It is not advisable to rake or throw these off, but better policy to have at least 2 men follow the scarifier with light tapping hammers, weighing about 2 or 2¼ lb., with long springy handles. These stones are made angular in shape by breaking and when again covered with gravel and silt, they will work in to the road and bond better with the other material on the road, and not so liable to shoot sideways when subjected to the pressure of the traffic as they did formerly. After the stones have been broken, the road is reshaped with a light grader and rolled.

This method of maintenance will average 1½ miles a day and cost approximately $25 to $30, depending on length of haul of water and coal. A gravel road requires intelligent maintenance.

Foreign Engineers Inspect American Road Construction.—Foreign countries, particularly those of South America and Japan and China, are much interested in American methods of road construction. In recent months the U. S. Bureau of Public Roads has been visited by several Japanese and Chinese engineers sent to this country to study the operation of the Federal and State highway organizations and to inspect actual construction. According to one of the Japanese visitors, his country has recently made its first appropriation for modern highway construction, an amount that would not be considered large by some of our States, but it is thought that the movement will grow rapidly when the people can see the benefits of the roads to be constructed with the present appropriation. In response to the interest in our roads shown by the South American Republics the Pan American Union recently issued an educational bulletin on American roads, printed in Spanish and Portuguese, describing American practice, and illustrated by photographs collected by the Bureau of Public Roads showing types of roads, road construction, and construction machinery. The bulletin will not only be valuable to the South Americans in solving their road problems, but should stimulate trade in American road machinery.

Method of Constructing Precast Concrete Slab Pavement for Wyoming Highway

A precast concrete slab pavement has been in satisfactory service for over a year on the Casper-Salt Creek highway in Natrona County, Wyoming. The pavement has been subjected to very heavy and severe traffic conditions. During the spring of 1921 it is estimated that 6,000,000 lb. of freight were moved over this highway in a single month from the warehouses and storage yards of a local refining company. A very conservative estimate of freight hauled by other companies during the same period amounts to 4,000,000 lb. In addition to this a weight of 100 motor vehicles per day passed over this main north and south state road. In an article in the February Concrete Highway Magazine, Mr. Z. E. Sevison, State Highway Engineer of Wyoming, states that the wearing surface of this pavement is in excellent condition and the slabs show no sign of displacement in spite of the fact that they have been subjected to extremes of winter and summer weather. The methods of constructing this pavement are described by Mr. Sevison in the above mentioned publication, from which we have taken the notes that follow:

Owing to the difficulty of procuring water and aggregates in the vicinity of the highway under consideration for improvement, the idea of casting concrete slabs at Casper and transporting them to the job was conceived. The accomplishment of this idea was further facilitated by five miles of concrete pavement already installed upon the highway over which the slabs were to be transported.

Early in the fall of 1920 a contract was let by the State Highway Department to the Levy Construction Co. of Denver, Colo., for manufacturing 2,400 lin. ft. of reinforced concrete pavement of this type. The slabs or units are 8 ft. long by 9 ft. wide and of a uniform thickness of 6 in.

How the Slabs Were Cast.—Separated and well graded sand and pebble aggregates were hauled to the plant in trucks and wagons and deposited in two conveniently located stock piles. Wheel-barrows were used to wheel the aggregates from the stock piles to the skip of the 2-bag batch Yaeger mixer. Cement in sacks was hauled to the job as required and placed into the skip by hand labor in the usual manner. The water for mixing was obtained from the North Platte River and was pumped through a 1-in. pipe line to a tank at the mixer and measured into the mixer as needed. A 1:2:3 mixture was used.

The mixed concrete batches were discharged from the mixer drum into two 2-wheeled concrete buggies which were pushed by hand to the forms, placed on a wooden floor. After being spread by hand, the concrete was struck off with a 2 by 6-in. wooden screed with a 2-in. steel strip upon its base, belted three times and edged. The mixture was made as dry as possible consistent with the necessity of entirely enclosing the reinforcement. As an excess of water appeared at the surface of the slabs, arrangements were subsequently made for a roller finish.

A level area of ground was selected for the floor on which the forms were to be placed. This was carefully graded; 2 by 4-in. joists, placed 14 in. center to center, were set with their tops slightly below the level of the surrounding earth and the intervening spaces carefully compacted by hand tamping to the top of the joists. One-inch planks were then laid with their finished side uppermost and nailed to the joists. Four board floors, each 116 ft. long and 20 ft. wide, were installed in this manner and covered with a roofing paper to prevent seepage of concrete mortar into floor board joints and to enable the slabs to be lifted without disturbing the floor. The 2 by 6-in. wooden forms were fastened upon the floor and adequately braced; each floor contained space for a double row of 14 slabs with a 6-in. space between rows and a 2-ft. overlap of platform at the edges.

On the first two types of slabs a 2 by 6-in. header board was used. Two other types, however, required an interlocking curved and warped surface at each end, and to obtain this, plaster of paris headers were cast by hand on a pre-molded pattern of the same material. These headers were painted with liquid paraffin to prevent adhesion of the fresh concrete. Every other slab was first cast, using these headers, which were then removed and the ends of the slabs painted with liquid paraffin and used as header forms in casting the intervening slab. The slabs were numbered as they were finished in the forms and were placed upon the roadway in the same consecutive order so that a perfect joint resulted. A flat surface was made in the usual manner at the end of each fourth slab and the start of the next succeeding series in order to provide for an expansion joint.

The Reinforcement.—The general style and placement of reinforcement was the same for all types of slabs. Transversely ⅝-in. round bars were placed 14 in. from each end of the slab and the next two bars of same size placed 10 in. and 6 in. respectively from the first bar at each end, leaving a space of 36 in. between the center bars. The bars were embedded 2 in. from the bottom of the slab. Under these bars was placed a layer of No. 049 A. S. & W. Co. standard reinforcing steel mesh extending through the entire width and length of the slab. The mesh reinforcement was laid upon the floor and pulled up into the concrete by means of hooks after it was deposited. Two pieces of 2-in. galvanized pipe 5 in. in length were embedded in the slab on each side 2 in. from the bottom and 20 in. from the ends of the slab. A ⅝-in. round bent rod was placed longitudinally in the slab 3 in. from edges and lapping over the pieces of pipe.

Placing the Finished Slabs on the Subgrade.

The reinforcement was designed more for the purpose of preventing breakage or cracking during the operation involved in transporting the slabs than to provide sustaining strength against heavy traffic.

After the concrete had obtained its initial set the slabs were covered with 2 in. of fine sand which was kept wet for 14 days. The first set of slabs were removed from the floors after 17 days, stacked up at the side and left in the yard for 30 days before being transported to the job.

Placing Slabs on Road Bed.—In moving the slabs, two large iron hooks were inserted into the two pipes embedded in each side of the slab, and by means of small hand jacks the slab was raised, placed on rollers, pushed to the edge of the platform and stacked in layers. Each slab was then lifted by a 3-ton triplex chain-hoist, operated on 3-ton rollers set upon 10-in. I-beam trucks mounted on A-frames. In this manner they were placed on trucks, carried to the job, removed in the same manner and firmly bedded on a thoroughly compacted sub-grade covered with a 2-in. sand cushion. The pavement was laid on one side of the 34-ft. roadway with a 1-in. slope toward the outer edge to allow for drainage. This plan allows for the future addition of an adjoining strip of the same width on the unpaved side of the roadway. Six types of heavily reinforced slabs were made, the contract calling for 50 slabs of each type.

The manufacture and placing of the slabs were subject to exceptionally thorough and competent inspection. A very smooth, even surface of flinty hardness was obtained.

New Films Show Road Building.—Close-ups of the activities of the U. S. Bureau of Public Roads are contained in two films recently released, "Building Bituminous Roads," and "Mixed Asphalt Pavements." The first mentioned deals directly with the surface treated and penetration macadam type of bituminous roads. "Mixed Asphalt Pavements" embraces the construction of asphaltic concrete and sheet asphalt roads, and carries the audience from the paving plant, where the materials are mixed, to the completed highway open for traffic. Scenes depicting the actual construction of the various types of roads were made under the direction of skilled engineers of the Bureau of Public Roads, United States Department of Agriculture, and are designed to instruct the layman as well as the engineer in modern road-building practices. Several animated close-ups graphically depict the details of construction.

The Highway Contractors' Problems

More Vital of Constructors' Problems Outlined in Paper Presented Before Chicago Good Roads Congress

By HENRY H. WILSON

Of Winston & Co., Contractors, New York [illegible]

Internal Relationship. The greatest problems of constructors fall under this heading and many of these problems are of their own creation. Perhaps the greatest of all relates to the education of themselves. This education should be conducted along the lines of cultivating skill, integrity and responsibility and eliminating the old time jealousy and distrust through encouragement of a spirit of cooperation and mutual helpfulness in every member of the industry. The individualistic tendency of the contractor dates from a time limited only by history and is believed to be more largely responsible than anything else for many of his existing problems.

It is good business for constructors to educate their competitors; it is good business for them to discuss each other's problems, construction and administrative methods; it is good business to get each other's viewpoint; it is good business and eliminates waste both to the contractor and owner to seek out the best means consistent with first class work and to assist in standardization of method and equipment along these lines. It is good business to secure added protection by all legitimate means. Organized construction can best promote these things. Sane, honest and common sense competition is better for all interested in highways than the destructive, individualistic tendency which has so often, in the past, made highway construction a financial shambles and brought upon it disrepute as a business proposition. The comparatively limited number of concerns which have been able to survive in the business, with profit, over any considerable period of years, is the proof of the foregoing points.

The Public. Until the past two or three years, there has not been the cohesive action upon the part of constructors necessary for the proper presentation of their case at the bar of public opinion. The better minds of the industry recognize that our problems must be solved with the welfare of the public constantly in mind and that it will be idle to attempt that which is not economically sound. At a recent highway conference, made up of representatives from almost every line of business directly or indirectly associated with highway work, a large number of axioms were displayed. The one receiving the most marked comment and unanimous endorsement read:

"If I knew you and you knew me,
'Tis seldom we would disagree."

It is to the interest of the body politic that the constructor should be better known and understood and it is one of his problems to place himself in such a position.

Lower contract prices are imperatively needed to secure greater mileage of roads for the public. The greatest reduction which can be brought about, would doubtless result if certain risks now assumed by the contractor were assumed by the state. It is almost superfluous to say that a contractor can figure closely on work in direct proportion as elements of risk and uncertainty are eliminated. In many states the assumption of these elements of risk and uncertainty are required by the organic law and can only be escaped by access to public opinion as expressed through legislative action. To bring about a change in these laws which will facilitate a more balanced and equitable form of contract, through the elimination of the above elements, as far as possible and thereby permit constructors to conduct estimating and operations along well established business principles is the problem not only of the constructor but of engineers and all others interested in highway building, who desire decreased costs and better stabilization of the industry.

It is also the problem of the highway builder to use his influence to create a public sentiment which will countenance better paid and better qualified engineers and inspectors. Constructors recognize that one of the greatest problems confronting highway commissions and chief engineers is a wage scale which will permit them to employ men more competent and experienced. It can be stated as a truism that good constructors invariably find engineers and inspectors satisfactory in direct proportion as the latter possess integrity, intelligence and experience and that the employment of high class men will invariably justify itself in an ultimate saving to the taxpayers.

As was pointed out in the recent report of the High Committee of the Associated General Contractors of America, the present investment in highways is held by many to be economically unsound and the elimination of all expense possible, without sacrificing quality, should benefit through better satisfaction upon the part of the public and a consequently increased volume of work for all interested.

Highway Departments and Engineers. The problem of the constructor here is to co-operate in pointing out those requirements of the specifications which entail increased costs without any commensurate advantage and those requirements which can be waived in the interests of economy without sacrificing quality. It is doubtful if there will ever be a set of specifications written for highway work which will not be susceptible of improvement, therefore, it should be the endeavor of all interested to constantly strive for improvement and economy in same. Many clauses now current suggest that the writers thought only of the equity lying on one side of their subject.

Contractors should endeavor to cultivate a broader and more sympathetic attitude, within their own ranks, as to the viewpoint and limitations of commissions, engineers and other public servants in their dealings. Many of us realize that, under present laws, the difficulty with commissions and engineers (as to many charges for which we are asking) lies not so much in their failure to recognize the just principle to apply as in finding a means to apply it practically.

Closer acquaintance and mutual discussion, in a collective way, between contractors and engineers, will do much to bring about that better understanding and co-operation which will stimulate, and react in, added technique, a larger medium of standardization, more economy of methods and consequent reduced costs. Organized construction is and has been moving in the direction of greater co-operation and it is hoped that engineers and others interested will not fail to recognize the mutual advantages to be derived therefrom. One of our problems is to bring about a realization, by all engineers and inspectors, that the constructor is their partner and not their bondman in a great work. When highway engineers, constructors, material producers, equipment manufacturers and all others interested come to a complete realization of the fact that they are confederates in the most stupendous work of our age (and one by which the future will doubtless chiefly judge our civilization) highway building will be reborn and most of our problems will have been solved.

In the matter of specifications, we believe it to be one of our problems to secure the settlement, by an impartial referee (when desired by either party) of disputes between ourselves and engineers as to the interpretation of specifications and matters of equity.

As was pointed out by William B. King of the Washington (D. C.) Bar, in his very able address before the Associated General Contractors of America last year: "The engineer writes what, in his judgment, has a certain meaning. The easy evolution of authority to the architect or engineer to decide all uncertainties, directly encourages vagueness in writing specifications." An engineer, with every desire to be fair, will oftentimes interpret specifications too much in the light of what he had in mind to safeguard when he wrote or adopted the specification in dispute. The working out of standard specifications for the country as a whole will save much effort and expense for which the taxpayers now pay.

Labor. Uniform and fair treatment of labor and possibly more uniform wages and working conditions for the various classes of skilled labor employed upon highways are believed to be a problem from which benefit can be derived. If it were possible to develop some co-ordinated industry in the northern and border states, whereby highway labor might be retained the year around upon some productive work, constructors would be able to secure greater economy and added efficiency from their organizations. Co-operation between concerns working in the same locality, in the matter of labor will go far towards stabilizing conditions and creating greater efficiency.

Materials—One problem here relates to the working out of a form of contract with material producers which will be a standard for the industry and more binding upon both contracting parties; in fact, it is believed that a solution of this cannot fail to reflect itself in decreased costs. The experience of many contractors with material contracts, during the war and post-war period, had a direct tendency to increase contract prices.

Another problem under this heading is the matter of responsibility for rejected material. Some producers refuse to accept responsibility for material condemned after unloading, while some engineers refuse to make final inspection until the material is unloaded. Uniformity of practice and understanding in this matter will remove an element of anxiety and loss to many constructors and will, doubtless, reflect itself in lower contract prices. Through the close co-operation of all, other inconveniences, delays and expense can be avoided.

Transportation.—Our chief problem, in this connection, is to assist the railroads and indirectly the public, in the elimination of waste and expense, by so designing work and unloading facilities as to provide for prompt release of cars. During the working season, thousands of railroad cars are devoted entirely to transportation of highway materials. Each expense can be avoided and added efficiency secured for the railroads through a study of car movements and routings.

Equipment.—The Engineering News-Record, in a recent editorial, charged that, during the past three years of intensified paving construction, contractors had done practically nothing towards standardization of methods and equipment. Standardization of equipment holds great possibilities for efficiency and economy and organized construction is already moving in this direction. Here again the working out of standard specifications for the country at large will do much to facilitate matters as it frequently happens that equipment suitable for construction in one state is not suitable in another.

Surety Companies.—One of our greatest problems lies in our relations with the surety companies, and it will, perhaps, be interesting to call attention to the following resolution adopted at a recent convention of highway constructors.

"Resolved that it is the sense of this meeting that a reduction in the cost of highway construction can be effected through a reduction by the surety companies of the premium now charged for contract bonds; and, it is believed this reduction will be justified by a more careful investigation upon the part of the Surety Companies, of contractors whom they bond."

This resolution was adopted, with a request, to a prominent surety executive present at the conference, that he present same to the surety companies' association for consideration and action. It is not going too far to allege that much demoralization has been caused in our industry (and much indirect to the taxpayers through delayed and unsatisfactory work) by the bonding of irresponsible concerns. Within the past ten years, there has been an increase of approximately 100 per cent, in bond premiums, and within the past 30 years, the increase has been comparatively greater.

In conclusion, it is believed that, when the problems outlined herein have been solved, there will be fewer abandoned contracts, less loss, trouble and expense to the public in being deprived of the use of its highways through delayed and unsatisfactory work, a saving to the taxpayers in cheaper work resulting from the elimination of improper risks in contracts, lower engineering costs through more expeditious execution of work, better work by better satisfied constructors, a better satisfied public and a better and cleaner highway construction industry.

Overloaded Trucks on Massachusetts Highway.—Every third truck on the Hartford-Springfield road and the Boston Post road in Connecticut was loaded beyond the capacity of the truck and the tires, according to a report covering two weeks of investigation on each roadway conducted by the U. S. Bureau of Public Roads, in co-operation with the Connecticut State Highway Department. Overloading occurred on all types of trucks, but was most common on the trucks of 3 to 5 tons' capacity. One 3-ton truck was found to have a 62 per cent overload. It was found that 89 per cent of the trucks on regular trucking lines had a total weight of truck and load in excess of 12½ tons, the maximum weight allowed by law in the State.

Constructing and Maintaining Gravel Roads in Muskogee County, Oklahoma

By J. H. TAIT,

County Engineer, Muskogee County, Oklahoma.

The highway system of Muskogee County, Oklahoma, today includes 95 miles of gravel roads, 53 miles of which represent Federal Aid projects built under the supervision of Federal, State and County engineers, the balance built by the county under the supervision of the county engineer. These roads average 18 ft. in width, and carry earth shoulders. The gravel which has been used throughout the work is a bank gravel, containing from 15 to 20 per cent clay, which acts as a binder for the mineral aggregate of the gravel. The mineral aggregate is mostly flinty chert and ranges in size from 1-in stone to dust.

The gravel is taken from the bank by steam shovels, placed on board cars, and hauled by rail to railroad spurs adjacent to the project to be constructed. From the spur it is transported by truck or wagon to the job. When the roadway has been satisfactorily graded, the gravel is dumped and shoveled and forked into place. It has been the practice in Muskogee County to construct the gravel pavement in two courses, the first being 5 in. after compression, and the second 4 in. after compression, so that the finished road is 9 in. in thickness.

Gravel Road of Muskogee County Highway System Treated With Texaco Liquid Asphalt.

The comparatively large percentage of clay found in the gravel contains a sufficient amount of moisture during construction to facilitate spreading and rolling. However, after the work is completed the clay loses all its moisture.

After this type of pavement had been in service for a short time, it became evident that the clay could not retain its position in the roadway unassisted, for traffic and surface drainage tended to remove much of it from between the stone, consequently loosening the stone in the road and causing rapid deterioration.

To prevent this, the Oklahoma State Highway Department has advised the use of a bituminous material as a surface treatment or carpet coat before the clay binder can be ground into dust under traffic.

Muskogee County has completed the surface treatment of 40½ miles of 18-ft. Salina type gravel roadway, using Texaco Liquid Asphalt No. 1, and applying approximately 0.4 gal. per square yard.

Immediately after the hot application of the asphalt from a pressure distributer upon the surface of the roadway, which has been swept clean of dust and loose foreign material, crushed flint stone ranging in size from ½ in. to dust, commonly know in this section as Joplin chatt, is applied at the rate of approximately 100 tons per mile. Rolling is regarded as superfluous, and traffic is allowed the use of the road immediately.

The county purchased one 800-gal. pressure distributer and has applied the surface treatment on its roads at an average cost of $700 per mile, including all labor and equipment, without charging off anything for equipment. This cost can be cut considerably as the handling of the chatt by hand [illegible] was very expensive and in a great many cases an excess of [illegible] was used. It is believed that this cost can be reduced to $600 per mile where the equipment for distribution of materials is owned and operated by the parties paying for the work. Of course, each application after the first can be made at a reduced cost as less material will be required.

Both state and county officials are highly pleased with the results obtained in the county.

The Co-Ordination of Highway Research

The nature of a research function, the present situation in highway research and the means by which the various state highway commissions may assist in developing as rapidly as possible the data for the scientific construction and operation of highways, were discussed by W. K. Hatt, Director, Advisory Board on Highway Research of the National Research Council, in a paper presented at the Omaha meeting of the American Association of State Highway Officials. An abstract of the paper follows:

The Nature of Research. Allow me to mention one by-product of research work, namely, the bringing together of men of apparently conflicting interests and those in controversy arising from misconception. Against the background of research, and a common effort to determine facts, acrimonious disputes are quieted, mere opinions are held in abeyance under the benign influence of the research for truth. The promoter and salesman drift into the background.

Then, too, how often has one of us seen foremen or inspectors quickened to greater vigilance and study when standard tests are applied to a material like concrete, and relative workmanship of operators is shown by some standard like the results of tests of field cylinders.

Research work when confined to the laboratory may be incomplete, often barren, and has been at time misleading. Something more than routine reception and control tests of materials is needed in a complete program. Research is something more than a demonstration to prove a theory or support an argument as in a law suit. It is as big as outdoors, and needs the co-operation of the engineers of design and construction as well as the testing expert.

The researcher, also, may proceed by statistics when he determines maintenance and other operating costs of road and vehicle, collects data of accidents and conducts traffic studies.

We have in the past confined our attention too closely to the materials of construction. Now we are alive to the need for research on the more extensive element of highway transport, the vehicle, and on the mutual relations of the vehicle and the road.

The simplest class of research is that wherein the influence of a certain element upon a result is sought, as for instance, the effect of water-content upon the strength of mortar, or of speed of operation of the testing machine upon the strength of steel, or of bitumin content upon the penetration test. Such work demands a carefully prepared working plan and systematic operations and known conditions. The tester knows in advance the element he has to deal with, and by a mechanical process arranges his tests so as to isolate each variable element and allow it to operate on the results. Of this class is also the work of standardizing methods of tests, so that operators in different laboratories may accept or reject materials uniformly. This class of experimenting is within the reach of a careful man with technical training, and demand only ordinary research ability. Here lies a useful field of work for the testing department of the state commissions in the [illegible] to develop significant tests for new materials and study their nature.

Large Scale Tests of Field Construction. A somewhat more difficult class of test is that in which a construction is subjected to loads like those of service to determine either fundamental principles operating or else empirical coefficients to aid the designer. The class requires a higher research ability and experience, more imagination, a keener analysis, and an engineering ability.

For example, the experimental road two miles long devised by Mr. Clifford Older of Illinois, and the Pittsburg Steel Co., and engineered by Messrs. Leonard and Aldrich of San Francisco, are attempts to subject a variety of types of pavement to an accelerated test and show a very high degree of scientific technique. At Pittsburg the traffic amounts to 10,000 trucks a day, at an operating expense of $500 a day, the total expense may amount to $150,000. An example that came under the speaker's observation was the oval track near Berlin, Germany, where in three months' service any railway track could be evaluated.

One aspect of tests of field construction on a large scale presents a difficulty in that these tests are in the public eye, and are often of an experimental nature in which constructions are loaded with a view to failure. These expected failures may be twisted by interested persons to mislead the layman, and be represented as a normal case. Again, in such tests of construction, but which become evident for the first time and which we know permit the designer to provide for them intelligently. And yet these deformations may be wrongly used as an argument against the type under study, rather than as a basis for improved designs of this type. It is this aspect of experimental roads which may explain the reluctance of producing interest to co-operate in such research work.

The large scale experiments demand co-operation between industry, the engineer and the trained researcher. There is always a danger of attempting too much. The program is subject to a change of plan during the test, because apparently no one is wise enough to foresee all conditions, in an unknown field. Yet with all these drawbacks, probably the most useful field of research is in the examination of the fundamental laws governing the behavior of constructions. A fruitful field of research is on subsoils, finding out what characteristic of each soil it is that determines its properties and evaluating them so that an engineer can examine a soil and then intelligently design a road to carry the load over the soil, or know what to do to improve its supporting power. Another example is the study of the laws of deformation of stiff slabs under loads, and the methods of reinforcing these economically.

It appears to the speaker that experiments on a large scale are necessary in each locality. The conditions of soil, climate and available materials are so different in this wide country that the findings of one state cannot be used entirely in another. The skilled engineer is needed to design a road as he designs anything else. Just now he is forced to work without adequate data.

An interesting and valuable field of research, also, is in the department of maintenance, not only for a correct principle of maintenance for each type, but also in the economics of maintenance.

Finally the research data must be obtained by disinterested agencies, by scientists who do not sell an idea to themselves, by trained experimenters who know from their experience the many pitfalls and blind alleys in this field. A part of our present data is incomplete, and belongs in the discard. Truth does not grow on every bush to be picked by the passer-by.

The Present Situation of Highway Research.—In the course of a rapid survey of the field in the states of Connecticut, Pennsylvania, Michigan, Illinois, Wisconsin, California and Washington, I have become aware of very substantial and praiseworthy research activities in the state organizations, and of the existence of a large mass of research data, much of which should be uncovered for the benefit of all. As it is now there seems to be no well defined channel of communication between the state highway commissions in respect to information of research, and of experiences in this rapidly growing field. It is not too much to say that decisions involving large sums of money are now made that would be qualified if existing information were made available.

We need, therefore, first of all, a census of research, and second, a research information service, to be circulated among the states, counties and cities, by which the data may be marshalled, boiled down, and put in useful form; and by which researchers may know what others are doing. For instance, three laboratories were, unknown to each other, investigating the strength of plain concrete under fatigue. Several isolated attempts are being made to design and test experimental concrete roads involving a heavy investment in the aggregate over a half million dollars. Many traffic surveys are planned without a clear idea of the purpose to be served and the significant data to be taken, or the devices for expediting the work. I do not say that it is not well to have several experimenters working independently in one research, but their efforts would meet with greater success if communication were established.

Thirdly, and most important, the people will be served if the state commissions will recognize research as the Bureau of Public Roads does and give formal status to a research and experiment division attached to the test department and tied up closely with the departments of design, construction and maintenance. My observation is that in the staff of state highway organizations there are men of the research type with the curiosity and the enthusiasm that lead a man to investigate unknown places, but who are now over-burdened with executive duties or tied down to routine work. Research men are not of the type of builders who want action. They are of the student type.

Now, research work that is adequate to solve present day problems cannot be done at odd moments, or by "trouble shooters," or by over-burdened executives with one ear to the telephone and the other to visitors. Research demands some isolation, a man must live in it, and have time for that slow and somewhat unconscious mental process that suddenly crystalizes into clear conceptions of the operation of nature's laws. The researcher must have time for careful planning, for the patient overcoming of experimental difficulties, and for close supervision of the work.

Is it not possible for the states to provide a division of research for field and laboratory research, and for the collecting and analyzing of statistics as an addition to the division of control testing? Is it not a duty? Two states with approximately the same climatic conditions, traffic density, and of nearly the same stage of development, adopt radically different types of construction, which will determine the future well being of highway transport. Decisions should rest upon the laws of engineering and economics. Our 20-billion-dollar highway transport industry must, like any other industry, succeed upon the basis of exact information.

Fourthly, in order that there may be co-ordinated attach, a map of the field of research should be spread out. In this each worker may find his best field of effort, which is often a local problem. How often have we seen universities seek for a field when material for research is waiting at their doors in the shape of traffic studies and analysis of cost of transport. Professor Dougherty of the University of Tennessee has shown us the value of work right at home.

I would make a plea for a closer union between the state highway organizations and the universities. Call the professors to conference, they will then more intelligently direct the efforts of the students whom later you will employ; and these professors will assist in working out some of your problems.

Plan for Action.—I have indicated that the frozen assets of research of the state organizations can be liquidated by the recognition of the research function by the states and by the use of the universities, many of which have experiment stations organized for such service. The Bureau of Public Roads is undoubtedly the most active agency for highway research and the chief vitally interested in this phase of the highway problem; the remarkable achievements of Mr. Goldbeck, in charge of tests and investigations of this bureau, have attracted the attention and admiration of the entire country. Workers are also found in other federal departments, the counties, the cities, and the industries. In particular, the recently organized research department of the Society of Automotive Engineers under the direction of Dr. Dickinson, is devoted to research in the vehicle as related to the road. Since $12 are spent on the whole vehicle where $1 is spent on the road, there is room for research on the vehicle, if we are to cut down the transport bill.

Now, all these agencies which work directly in the field or else on collateral problems, should be co-ordinated. I do not know of any organization so well designed for this purpose as the Advisory Board of Highway Research of the National Research Council. This board has been active since August, 1921, and has so far been studying the best plan of action. It works through committees representing the field of economics, operation, design and construction. Messrs. Agg, Mattimore and Goldbeck head three of the committees. The contact of the advisory board with the states will best be through the committees of this organization. A committee which will prepare a uniform cost accounting system for maintenance, and collect significant data, will advance the economics of highway transport. It is a matter to be thought out carefully if a useful end is to be served. Technical committee work has been overdone in some of our older societies, and much duplication of program and interlocking membership have grown up in the past. Dead timber should be eliminated and new workers be found.

If the advisory board can unlock the resources of highway research and co-ordinate our efforts, as I believe it can, functioning as the directing organization, additional financial support must be secured. This support must be from disinterested agencies. As yet the work of the advisory board is to be adequately financed.

It is hoped that the state commissioners may find it possible to co-operate with the National Research Council, as the Bureau of Public Roads and the Engineering Foundation are now co-operating, by some form of agreement or contract under which the state may find co-operative funds available and payable to the National Research Council for services in supplying information and directing that research will be to the benefit of the taxpayers of the state.

The members of this association will not fail to appreciate the need for an early and serious study of the highway problems of the present day and the need for preparation for the future.

The thousands of young highway engineers in the service of the Federal Government, the states, the counties and municipalities, are not engaged in a temporary job. Not only have they 15 or 20 years of construction ahead to create the main arteries—provided the confidence of the public is continued—but they must prepare themselves to maintain and to operate these highways. The young men are members of a branch of engineering as distinct as that of railroad engineering—and indeed in many respects demanding wider powers than the latter and from which but a limited amount of practice can be transferred. It is for the present day leaders to prepare these young engineers for their future duties, to stabilize this branch of the profession, bring a sense of solidity to the members.

Local Highways Becoming Long-Haul Thoroughfares

Some interesting facts regarding the percentage of through traffic on a road which formerly carried only traffic originating within 5 or 10 miles of the highway were brought out in a report of two traffic censuses taken by the U. S. Bureau of Public Roads in co-operation with the State Highway Department of Connecticut. The roads selected were part of a fairly complete system of highways. The first census showed an average of 2,907 passenger cars and 281 trucks passing the recording station a day; and the second, 3,832 cars and 511 trucks. Forty-seven per cent of the cars came from without the State. Drivers were questioned as to length of travel for the day, and results showed average figures of 70 miles and 52.4 miles for the two censuses.

The average haul for truck traffic was 47.5 miles, some of them hauling a distance of 250 miles. Officials point out that traffic of this nature has developed in a period of something like 10 years on a road which prior to 1910 carried almost entirely local traffic.

Paving Costs on Country Roads.—Average costs per square yard of various types of paving for country roads have been compiled by the U. S. Bureau of Public Roads. The figures cover 68,000,000 sq. yd. of paving constructed with Federal aid in all parts of the United States during the period 1916-1921. The costs per square yard are as follows: Sand-clay, 18 ct.; gravel, 46 ct.; plain and surface-treated macadam, 95 ct.; bituminous macadam, $2.10; bituminous concrete, $2.50; plain cement concrete, $2.57; reinforced-cement concrete, $2.74; and brick, $4.10. These figures cover only the cost of the paving; they do not include the cost of grading, and officials point out that it must not be assumed that roads of the several types can be constructed in any locality at these figures. For example, the cost of bituminous concrete varied from $1.70 in the New England States to $3.13 in the group of States, including Kentucky, Tennessee, Mississippi and Alabama. In one group of states the cost of brick dropped to $2.40.

Bituminous Foundations for Pavements*

By HUGH SKIDMORE,

[illegible] Paving Laboratory, Inc., Consulting and Inspecting Engineers

The two most important elements affecting the design of pavements for both city streets and county roads are the character and the intensity of the traffic to be carried. These two factors combine to determine the probable destructiveness of the most potent of all traffic forces—impact. There are other important considerations, such as bearing power of soil, temperature variations, drainage, quality and quantity of local materials, etc., but all of these are of secondary consideration when compared with traffic. The remarkable changes in kind, weight and speed of vehicles which have occurred in the last few years, have necessitated departures not only from some of the accepted practice formulae pertaining to various pavement types, but also from some of the previously conceded standard types of foundation and wearing surface construction.

It is ridiculous to assume that any one type of foundation or wearing surface will prove the best under all conditions. In fact it is often times the case that more than one basic design should be used within a given length of pavement and until this fact is more generally recognized, failures will continue to be more prevalent than they should by reason of the known limitations attending any given basic design.

Two schools of thought as applied to pavement foundations have been evolved. These are essentially different in their fundamental principles. One of them seeks to overcome the destructive effect of the traffic loading, which at any instant may be converted into impact of variable intensity and often equivalent to several times the dead load by means of a rigid slab possessing strength superior to the possible force of impact; the other dissipating the blow by absorbing a very considerable portion thereof through a flexible structure which is always in actual contact with the subgrade, thereby insuring greater uniformity of load distribution and functioning as a distributing medium or foundation and not as a deflector.

Flexible Types Discussed.—Flexible and semi-flexible pavement structures are the oldest type known, and we have only to picture the old Roman roads to realize that the soundness of such construction was thoroughly demonstrated long ago. Although modern traffic requires a wearing surface of superior quality, it is debatable whether highways as they are so often built in this country today will ever prove as truly economical as they would if we employed more generally the old idea of a built up road bed, and then laid upon this our modern traffic floor.

Flexible foundations include gravel, broken stone, water-bound macadam, bituminous macadam, and hot-mix bituminous concrete. They are usually classified as to value in a pavement structure in reverse of the order named with bituminous concrete as the highest type. It is estimated that there are 15,000,000 sq. yd. of "block base" giving satisfactory service in this country.

The bituminous foundation structure although possessing considerable beam strength, functions primarily as a shock reducer, that is, it gives slightly under the blow of impact in transmitting the load to the subgrade. Therefore, the design of this type places considerable reliance in the load supporting power of the subgrade. Its use then is dependent upon a knowledge of the ability of the subgrade to support loads equal to the probable force of impact reduced by the beam strength residing in the bituminous structure, whereas the rigid type regardless of the bearing power of the soil, must be built to sustain the entire force of impact. For this reason, a much thicker rigid foundation is required under given traffic and subgrade conditions, as has been demonstrated by impact tests.

It will be readily seen that even where soils are of questionable value as a subgrade, bituminous foundations may still be employed economically, if an artificial subgrade of broken stone, gravel, builders, or even cheaper materials, is first constructed. When old macadam or gravel roads already exist an excellent artificial subgrade is offered at almost negligible cost. If widening is necessary, this can usually be accomplished as in the case of the Kingston Pike at Knoxville, Tenn., where "black base" was laid about 4 in. thick over the old macadam and 7 in. thick at the edges of the widened pavement.

In the west, where the most extensive yardage of bituminous foundation has been laid, the general practice seems to be in taking alternate bids to specify 5 in. total depth for "black base" pavement and 7 in. for Portland cement concrete pavement of 1:2:3 mix. Almost universally bids for "black base" pavements have been less than for either Portland cement concrete pavement or asphalt wearing surface on Portland cement concrete base. The saving has varied from 20 to 60 ct. per square yard.

Contractors' Views. The opinions of contractors are always necessary and valuable since the very nature of their business requires that they give very careful thought to cost and practical construction features. With this idea in mind I have taken advantage of every opportunity to discuss with them construction problems and costs. In order to obtain an even more representative idea of their experiences and views regarding bituminous base, questionnaires were sent to well known concerns throughout the country. Both the number of replies and valuable data contained in them greatly exceeded expectations. The combined activities of the contractors who replied cover every state of the Union as well as parts of Canada, and therefore can be safely considered as representing the general attitude.

Briefly, the experience of contractors is such that they are willing to guarantee "black base" as readily as Portland cement concrete, and with few exceptions, stated that less risk was attached to "black base." The experience of contractors generally has been decidedly lower maintenance expense, and lower first cost except in a very few instances where freight rates proved to be an extraordinary item. Assuming equal depth of foundation, the use of same aggregate materials in both types, and Portland cement concrete not to exceed 1:2:5 in richness of mixture, 96 per cent estimated a difference in initial cost of from nothing to 50 ct. per square yard less for "black base" and 75 per cent estimated "black base" at from 25 to 50 ct. per square yard less than Portland cement concrete. Since it is true that under similar traffic and subgrade conditions, less depth of "black base" is required, it will be readily seen that rigid foundations will usually cost substantially more than the highest type of flexible base.

One contractor said that during the past 14 years 85 per cent of the pavements he has laid have been upon flexible foundations, including broken stone, macadam and a goodly yardage of "black base." Certainly this contractor's experience with this type of foundation has proven highly satisfactory.

The only objection raised to "black base" construction by any of the contractors was the possibility of idle equipment in the event a protracted rainy season was encountered on work where the subgrade did not drain readily. Undoubtedly such a combination of circumstances would delay almost any kind of paving construction. However, it is quite probable that it would prove more serious with bituminous work than in the case of rigid base. If it is known that such local conditions as these are at all probable, it would seem that the engineers would provide for such a contingency by specifying an alternative.

Conclusion.—In summing up the advantages of bituminous concrete foundation it is thought that some of these referred to in previous discussions will bear repetition:

1. Because of greater resistance to impact, permits the use of a thinner base course than is required of the rigid types.
2. Provides uniform contact with the subgrade, thus insuring greater uniformity of load distribution, and precluding the necessity of relying upon the pavement structure to sustain the entire force of the traffic loading.
3. Provides homogeneity of mass and positive bond between wearing course and foundation when bituminous top course is employed.
4. Provides freedom from cracks, upheavals, and ruptures which are common to rigid types.
5. Insures against the presence of moisture in the foundation structure, thus prolonging the life of the pavement.
6. Does away with the long period of time required for the curing of Portland cement concrete, thus permitting the

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*[illegible] presented [illegible] annual convention [illegible]

opening of completed work to traffic immediately and providing a greater rapidity of turnover to the contractor.

7. Permits the use of the same aggregate materials as are ordinarily employed in Portland cement concrete foundations, and provides decided construction economies.

8. Under given conditions costs substantially less than rigid construction.

9. Maintenance expense is less than for rigid pavements.

10. May be easily repaired at minimum cost, the surface patch method being applicable except in the case of very serious defects

Varieties of Paving Brick Reduced to Seven

Elimination of 59 varieties of vitrified paving brick, reducing the styles and sizes in use from 66 to 7, was announced last week at the U. S. Department of Commerce, as the result of meetings between representatives of the industry concerned and the Commerce Department's newly established Division of Simplified Commercial Practice.

At a meeting held Nov. 15 of last year, the varieties of paving bricks in use were reduced from 66 to 11. At a meeting March 27, lasting only two hours, the number of recognized varieties was further reduced to seven.

The action of the November meeting of the joint conference of representatives of the manufacturers, distributors, and users of vitrified paving brick received the endorsement of the Chamber of Commerce of the United States, of the American Society of Civil Engineers, the American Institute of Architects, the American Association of State Highway Officials, the National Paving Brick Manufacturers' Association, and other engineering societies, clubs and organizations, along with some of the Federal departments which have adopted the recognized types and sizes of paving bricks as standard in their specifications. In addition, since the November conference was held, 46 individual manufacturers of paving brick, acting independently of their trade organizations, have endorsed the action of the original conference.

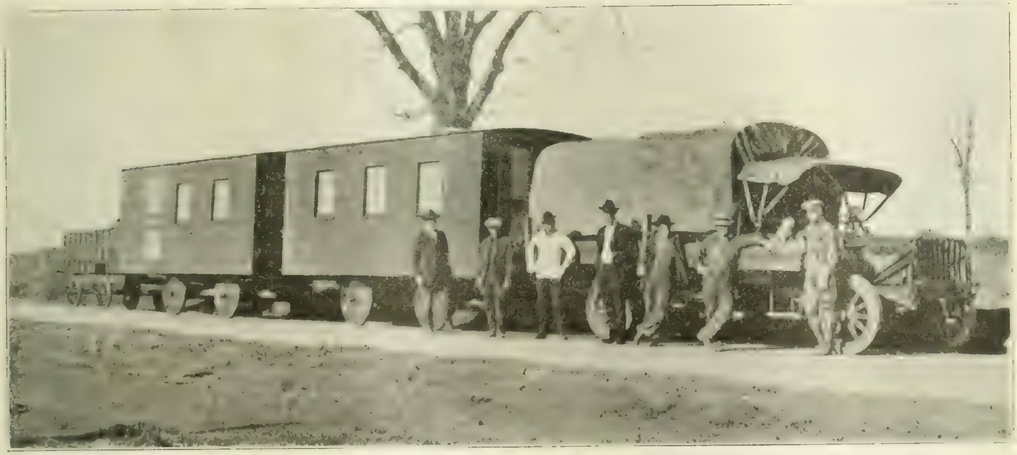
The four additional eliminations, unanimously agreed upon to take effect at the end of a year, are one size, 3x3½x8½ repressed lug brick; two sizes—3x4x8½ and 3½x4x8½—of vertical fiber lug brick; and one special wire-cut lug hillside brick, 3½x4x8½. The total shipments of these types and sizes of brick in 1921 are approximated as 10 per cent of the total shipments.

New Virginia State Highway Commission.—Governor Trinkle of Virginia has signed the bill for reorganizing the State Highway Commission. This bill gives the Governor the authority to name the five members, one of whom is to be the chairman, who will be vested with power to conduct all business of the State Highway Department. Besides the chairman, one of the members is to be a highway engineer, whose designation is to be State Highway Commissioner.

Camp Cars Adapted from Trailers

Camp cars made from trailers are used for housing "floating" bridge and maintenance gangs of the North Carolina State Highway Commission. These trailers were surplus war materials and were originally intended for use in hauling supplies and ammunition. Several of these camps have been constructed in the various districts throughout the state, all of which are similar except for minor details. The following description, taken from the North Carolina Highway Bulletin, relates to a train built under the direction of O. F. Yount, Bridge Construction Superintendent, for use in repairing bridges on the state highway system. The arrangement described is typical of the general scheme of construction.

The camp train consists of the truck which furnishes the motive power, a sleeping car, a dining and kitchen car, and the small-tool car. The latter, however, is an especial adaptation which was originated by Mr. Yount.


Camp Car Train for Floating Bridge and Maintenance Gangs of North Carolina Highway Commission.

The truck is a 3-ton Packard, known in the army as the "Standardized B, Heavy Cargo Truck." Except for building supports on either side for carrying painting scaffolds, these trucks were used without change. Heavy tools, rope and other bulky equipment, are carried in the back of this vehicle at a minimum cost of labor and time.

Coupled next to the truck is the sleeping car. In each corner of the car is placed a double-decked steel bunk or cot, thus furnishing sleeping accommodations for eight men, while in the center of the car is a small heater. This arrangement gives the maximum amount of clear floor space so that the eight men who usually make up a gang can live very comfortably. There are three windows on either side of the car and a door in each end which provides a sufficient amount of ventilation. When closed the car is as tight as the ordinary dwelling and can be made comfortable in any kind of weather. The inside dimensions are approximately 17 ft. 6 in. in length and 8 ft. in width.

A very conveniently arranged dining and kitchen car is a part of every camp outfit and is coupled behind the sleeping car. On either side of the car in the end next to the sleeping quarters are folding tables, the legs being arranged so that when not in use the tables can be folded flat against the wall. Along the wall above the tables are shelves for storing provisions, on the edges of which are nailed strips of wood so as to prevent the supplies from spilling when the train is in motion. On the left hand side of the kitchen end of the car is a cabinet, the upper part of which contains shelves for storing dishes while the lower part is arranged for the storage of pots and pans. The top of this compartment is finished up so as to furnish a table upon which the cook may work. On the right hand side is the stove which is an ordinary wood cooking stove of a size that conveniently fits in the space available. In moving from place to place it is necessary to take down the section of stove pipe which projects above the roof of both the cooking and sleeping cars but this difficulty was easily overcome by using a slip joint and guy wires for holding the pipes when in use but which can be quickly detached when work is completed at one bridge and a move is made to another. As originally designed and in some cases built the doors in the dining car were arranged as in the sleeping car, but it was found that it was difficult to get the stove in the car, so a window was substituted in the end of the car next to the stove and a full-size door built in the side of the car, a change which has proved to be a convenient one.

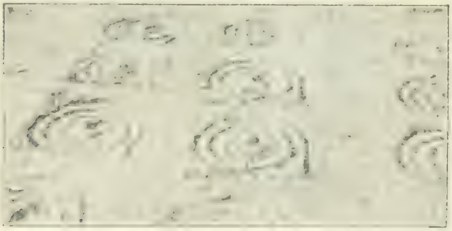
Both of the cars are built on the chassis of the standard 5-ton trailers, a number of which have been received from the Government. Except for removing the bodies from the trailers the only change made was in the couplings of the cars. The projection of the end of the car over the end of the chassis made it necessary to use a draw bar with universal joints on either end to couple the cars together.

Last in the train, but no means least in importance, is the small car which is used to store small tools and supplies. This wagon is rather ingenious in construction in that it is made up of two parts of entirely different vehicles. The chassis is that of a $1\frac{1}{2}$-ton army "Cargo" trailer while the body is that of an army "Combat" wagon. Very few changes were necessary to make this into an admirable tool wagon.

All of the construction work on the train is of the first class and the bodies are well finished up. On the inside of the sleeping and dining cars the woodwork is finished in a light cream color while on the outside all of the cars and the truck are painted the standard brown color used by the State Highway Commission. The windows and doors of the cars are well screened, which adds very materially to the comfort of the men during the summer. Considering the amount and quality of work done in overhauling the cars the cost of doing so, approximately $250 per car, is very reasonable. By having comfortable quarters in which to live a better class of workmen can be secured and more efficient work done.

A Method of Binding Concrete Base and Bituminous Pavement

In bituminous pavement construction last season on several roads in Atlantic County, New Jersey, a new device developed by the Standard Bitulithic Co., the contractors, was used for securing a stronger bond between the base and the surface in bituminous pavement work. A square tamp on the face of which is fastened a spiral of $\frac{7}{8}$-in. steel cable was used with the result shown in the illustration, which is reproduced from The Highwayman. This device was employed on the Pleasantville-Mays Landing Road, the DaCosta-Hammonton Road and on Route No. 4 from Absecon to the Sea View Golf Club. Alexander Howard Nelson, Atlantic County Engineer, is in charge of the work.



New Finish on Concrete Base

18-ft. Bridges the Rule on Federal Aid Roads. Few highway bridges with a width of roadway less than 18 ft. are now being constructed on improved roads, according to engineers of the U. S. Bureau of Public Roads. In the past some of 12 ft. and a great many of 16-ft. width have been constructed in an effort to economize, but it has proved short-sighted economy. Only one lane of traffic can pass over a 12-ft. roadway and 16 ft. of width will not accommodate two lanes in safety. Many of the States, such as Pennsylvania, New Jersey, Ohio and Massachusetts have found it advisable to reconstruct the bridges on important roads to make them wide enough to accommodate three and four lanes of traffic.

Simple Sprinkling System for Curing Concrete Pavements

An inexpensive, easily handled and efficient method of curing concrete pavement was used by J. L. Smith in a $2\frac{1}{2}$ mile improvement at Seattle, Wash. The method is described by W. H. Tiedeman, assistant city engineer of Seattle, in the February Concrete Highway Magazine.

The contractor had on hand from former county contracts a large quantity of $1\frac{1}{4}$ in. pipe in about 20 ft. lengths. These were coupled together with tees into which a $\frac{1}{2}$ in. nipple 3 in. long is screwed; a stationary brass cap known as a "Mutt" sprinkler completed the installation. A simple adjustment of a screw regulates the amount of spray. The connected line was attached to a hydrant, which are about 300 ft. apart in Seattle, and the concrete gang carried the connected pipe on to the previous day's work, which took only a few minutes. One man was employed to take care of the system during the day. On a recent job 1-in. pipe was used and an even smaller diameter may prove sufficient for the supply line. Meters show that 41 cu. ft. of water are used to wet 100 sq. yd. per hour.

Curing Concrete Pavements on Tenth Avenue, Seattle, With Mutt Sprinklers Attached to $1\frac{1}{4}$-In. Pipe.

The sprinklers were required to be in operation during the ordinary working hours, but in the summer months the night watchman was instructed to turn on the water about sun-up and to turn it off after sundown. The summer nights at Seattle are always cool, so it was not expected that serious evaporation would take place.

Mr. Tiedeman states that the first cost of such equipment is small, and the results are so satisfactory that its use will be specified on all future work for both concrete paving and concrete base in Seattle.

Cost of Grading for Highways

A great variation in the conditions under which grading for highways is done in different sections of the United States is reflected in cost data compiled by the U. S. Bureau of Public Roads on 1,350 miles of Federal aid road. The figures cover the four-year period 1917-1921 and are based on a total of $24\frac{1}{2}$ million yards of earth. For the groups of States the average price per cubic yard is as follows: New England and Middle Atlantic States, $1.33; East North Central, $0.68; West North Central, $0.49; South Atlantic, $0.61; East South Central, $0.41; West South Central, $0.35; Mountain, $0.52; and Pacific States, $0.61. The general average price was $0.56. Probably the most important factor affecting the cost was the amount of grading to be done per mile, the quantity being very small in the groups having the highest prices. In general it is noticed that where mostly old roads are rebuilt, the light work and tearing up the old pavement greatly affected the cost. The amount of fine grading or trimming required for the higher types of pavement was also a factor. Labor costs, character of soil to be graded, climatic conditions, time limit on contracts, and cost of detours for traffic also affected the cost. While each group of States did not have the same volume of grading each year, and therefore the average figure for the whole country is not truly representative, it is interesting to note that the average cost of grading gradually rose from $0.49 in the first quarter of 1917 to $0.67 in the fourth quarter of 1919, and then gradually declined to $0.34 in the third quarter of 1921. It is probable that the latter figure would be somewhat higher had all of the States let work in that quarter.

How 30-Year Old Brick Pavements Are Serving Lynchburg, Va.

By BOYD A. BENNETT.

Director, Department Public Works.

A generation ago, in 1892, to be exact, the property owners on Court St., in Lynchburg, Va., were in dispute concerning the kind of pavement to be laid. Lafayette P. Rodes was the City Engineer under Mayor R. D. Yancey, and his records tell the story.

Some of the property owners were anxious to try vitrified brick for the first time. Others objected because of its higher first cost in comparison with other paving materials. Arguments as to low maintenance cost and probable long life of a brick pavement prevailed in the end, and vitrified brick were used.

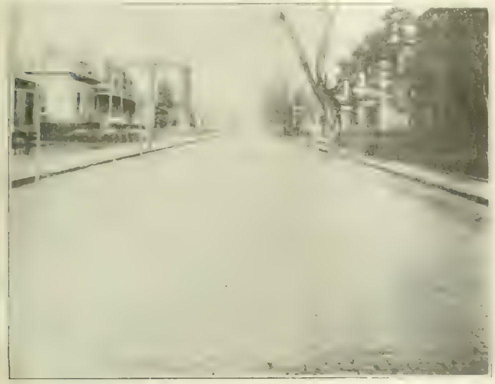


Fig. 1.—Court St., from 9th St. West, Paved in 1892.

That pavement is in use today, is in good condition, and we do not anticipate at this time any improvement on it with the exception of keeping out the holes caused by settlement. (See Fig. 1.)

That same year Cabell St. was paved with vitrified brick. The street previously had been paved with macadam and this old surface was utilized as a base. This brick pavement is giving service today and Fig. 2 shows its condition. In both of these streets a sand filler was used.

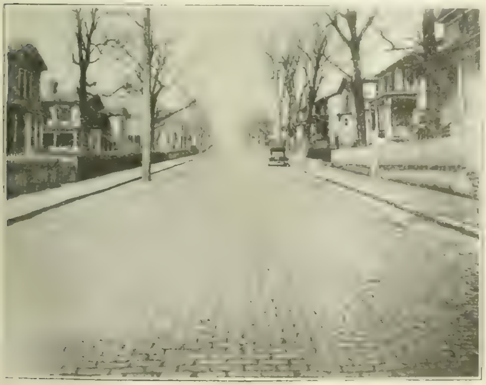


Fig. 2.—Cabell St., from D St. West, Paved in 1892.

Lynchburg, a city of more than 30,000 population, is located on the James River and is the shipping center of a large iron and tobacco producing region. It also is an industrial center with numerous factories.

In 1895 a number of our merchants, together with the Southern R. R. Co., petitioned for the improvement of the lower end of Cabell St. between the railroad tracks and Orange St. with brick, and the work was done in 1896, at a cost of $1.75 per square yard, Mr. Rodes still being city engineer. The City Engineer's report for this year gives the following detail regarding this pavement:

"The natural foundation was rolled and rammed and upon this was laid from 4 to 6 in. of concrete and the interstices in the brick pavement were filled with Portland cement. A portion of the area thus paved covers what was at the time a deep cellar of a building and was on a triangular strip of ground donated by the railroad company. This basement was filled and a wall to retain the same was erected. Exceptional care was taken in ramming the basement, filled in thin layers. The filler used in this portion of the brick pavement was boiled tar pitch."

Market Square was done away with some years ago and the city auditorium now stands on that site. At the time it was torn up, however, the pavement was in excellent condition.

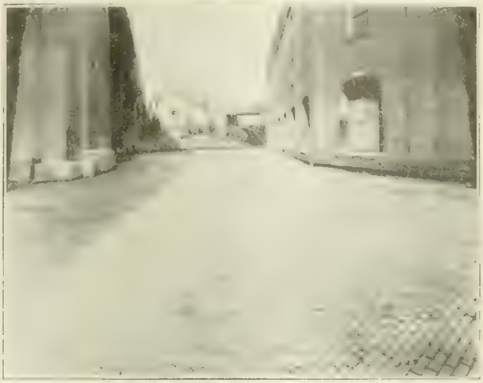


Fig. 3.—Cabell St., in Front of Southern Ry. Station, Paved in 1896.

Fig. 3 shows the condition today of the pavement in front of the freight depot. This is not a through street and all trucks and wagons have to back up and turn around on this pavement, causing severe abrasive wear. Traffic is unusually heavy, as is customary around freight depots. The pavement is in good condition and we do not anticipate any maintenance whatsoever.

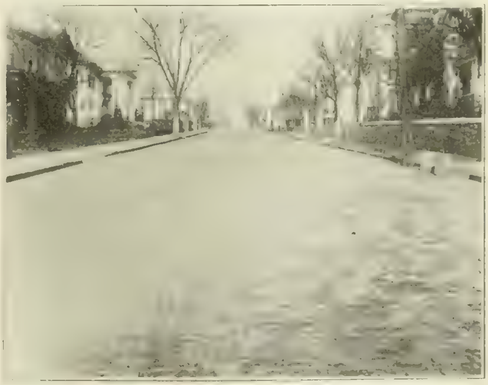


Fig. 4.—Madison St., from 5th St. West, Paved in 1899.

I might say that wherever maintenance has been necessary on any of the brick streets it has been due to failure of the foundation and sand filler as a consequence of the exceptional increase in weight and amount of traffic in late years.

The next important piece of vitrified paving was laid in 1899 on Madison St. between First and Fifth Sts. L. P. Rodes was still city engineer. It was first intended to pave this stretch with rubble stone, for which a bid had been received at 83¾ ct. per square yard. Property owners, however, petitioned for brick, guaranteeing a cost not to exceed [illegible] per square yard. This cost, lower than the Cabel St. paving in front of the depot, was arrived at by deciding to lay the brick on the natural soil compacted and with a cushion of coarse sand.

An examination of the soil showed it to be a strong clay mixed with gravel. The bid for brick was accepted and the work started. Sand was used for filler. Because of the inability of the brick company to furnish a sufficient number of the grade of brick required under the high standard set by the city, it was necessary to accept "inferior" brick, as measured by this high standard, and a bond guaranteeing their quality.

In his annual report for that year City Engineer Rodes greatly regretted the fact that the so-called "inferior" brick had been used and predicted the failure of the pavement.

At this writing, after the street has been in use for 23 years and without a cent spent for maintenance, except for foundation failures, there has been no failure of the brick as anticipated by Engineer Rodes. Fig. 4 shows the condition of the pavement today. This may mean either one of two things: either that the standard set by the engineer was unnecessarily high, or that the so-called "inferior" brick were of better quality than he thought. The brick on this street show a wear of about ½ in. and are cobbled because the sand filler offered little protection.

Carrying out the recommendation of Mr. Rodes, the new city engineer, E. D. Slaner, in 1901 laid additional brick pavement and he in turn recommended in his 1901 report that brick be used in other streets.

In connection with the Madison St. pavement, I might say that today the property owners are petitioning for a narrowing of the 60-ft. street to provide a parking place. This request, in face of the good condition of the brick, is because of the unevenness of the surface caused by foundation failure and cobbling of the brick due to lack of protection by the sand filler. The extraordinary width of the pavement and the fact that the street slopes slightly to one side, making it somewhat unsightly, also is an argument for repaving.

Upon careful examination I find that the brick are in good condition, and all that is necessary to make this a new pavement is to relay the brick, using the best side up, and applying asphalt filler.

Between 1901 and 1921 Federal, Floyd, Clay, 15th, 16th, 7th, 4th, Harrison, 12th, 11th, Church and 5th Sts. were paved with brick, the last four in 1921.

Up to 1911 when the last brick street was laid outside of those laid in 1921 we had the following pavement mileage in Lynchburg:

	Miles
Brick	2.28
[illegible]	2.42
[illegible]	8.00
[illegible]	4.14

Maintenance costs for the year 1910, when we had the mileage given above, were:

Brick	$ [illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

The bahavior of vitrified brick pavements in Lynchburg leads me to the following conclusions:

1. While brick pavements cost more than some other pavements in the beginning they are more than worth the extra cost if properly constructed because of their exceptionally long life and low maintenance cost.

2. Good brick pavements for moderate traffic have been successfully built on a thoroughly compacted natural soil where a sand cushion was used on the natural soil and the soil was of such character that it drained easily.

3. However, for present-day traffic, it is believed they should be laid on a rolled stone, gravel or other base. Had asphalt filler been used on the pavements above mentioned, it would have helped to retard the cobbling of the brick.

Machine for Testing Gravel for Road Building.—To aid the U. S. Bureau of Public Roads in giving particular attention to the use of local materials in road construction wherever possible, a simple portable apparatus has been devised for testing gravel to determine its suitability for concrete. The device consists of two steel balls arranged so that a piece of gravel can be placed on top of one of the balls and the other ball dropped on it from different heights and strike the gravel. The height of fall required to break the gravel is an indication of its ability to withstand the blows of traffic.

Some Fundamentals of City Planning Illustrated in the Plans for Watertown Square and City Hall

By JOHN NOLEN, Town Planner

(Following is a very slight condensation of Mr. Nolen's report made in 1921 to the Planning Board of Watertown, Mass. It presents in compact form a very effective account of a minor city planning problem and its solution. A map accompanying the report shows the existing layout and the proposed solution, and discloses among other interesting details, a considerable auto parking space adjacent to the city hall.—Editor Engineering and Contracting.)

As a basis for our studies and recommendations a simple survey has been prepared, which, however, furnishes all the data necessary to give efficient knowledge of the existing conditions for our purpose. The information obtained has been shown graphically on a number of prints of the map of Watertown and submitted to the Planning Board.

The general plans or diagrams of the surveys are four in number, namely, the Existing Conditions, Main Thoroughfares, Public Properties and Population Distribution.

The first of these survey plans, entitled Existing Conditions, shows the public and semi-public properties, railroad and industrial property, stores, main roads and car line streets. The second diagram gives a graphic separate presentation of main thoroughfares. The third diagram shows public properties independent of the other features on the Existing Conditions map. The fourth, the population distribution by enumeration districts, in accordance with the 1920 U. S. Census.

In addition to the data covering the entire area of the town, more detailed surveys have been made showing valuations, property lines and building occupation of that section of the town described in the vote under which our work has been done. We have considered this area as Watertown Square and recommend that it be known as such. The use of the term "Beacon Square" for part of the area seems to us confusing.

We also submit with this report as a contribution toward the understanding of the local conditions a collection of Watertown photographs covering the region of Watertown Square and other near-by sections studied in connection with the present town planning project.

The gist of the recommendations, based upon painstaking field work, consultations with the Planning Board, and a careful consideration of all the local conditions as shown by the survey, are as follows:

1. That the property known as the Kelly Corner, bounded by Mt. Auburn, Arsenal and Taylor Sts., be purchased and developed as the site for the proposed town hall.

2. That the property known as the Morse and Hosmer, et al., location, between North Beacon and Riverside Sts., be acquired also and held for future public and semi-public buildings, the actual locations and sites to be determined and allotted as occasion arises in the future.

3. That building lines be officially established in accordance with the plan which we are submitting, entitled "Proposed location for town hall, together with other changes suggested in Watertown Square."

4. That Spring St. from the railroad to Main St. be abandoned as a street, and a new traffic way to Merchants Row opened.

5. That the present Delta in the Square be improved and developed as proposed on the plans submitted.

The general location for the town hall building has been pretty commonly agreed upon, and our recommendation coincides in the main with the conclusion reached by the New Municipal Building Committee and submitted by them a year ago. However, the exact location of the site, the orientation of the building and the preparation of a comprehensive scheme of improvements for Watertown Square involves more than merely selecting a town hall site. Such action cannot be taken as an independent problem, because it is intimately related to and dependent upon the right solution of other town planning questions, especially those related to traffic regulation and control.

All things considered the lot recommended for the town hall site appears to us the best for the purpose. It is accessi ble, dominant in its relation to the Square, adequate in area, suitable in shape (provided the new property and building lines are established), and reasonable in cost. The fact that this property is at present covered by buildings of quite unusual unsightliness, while not an important reason for our recommendation, is an additional advantage that would result from its public acquisition and development.

We are of the opinion that the acquisition of the Kelly site would not be sufficient in itself, but that the town should also acquire and control the unusually well-located block on the axis of Main St. between N. Beacon St. and the Metropolitan Park Reservation. This property does not appear to us as well adapted as the Kelly site for the town hall itself, but Watertown needs new sites for other buildings, and will require more in the future. Moreover, the merit of the Kelly property as a town hall site depends to some extent upon the control and proper occupancy of the Morse and Hosmer property.

Our conviction as to the pre eminence of the sites recommended as the best locations for the center of the town life was not reached without a thorough-going examination and study of all other possible sites fronting on the Square, and also those in the neighborhood of Saltonstall Park—practically the only alternative region. Our studies and examination of local conditions in the field served only to confirm the conclusions that we had reached.

Of almost equal importance with the selection of the town hall site and provision for future buildings is the improvement of the whole appearance of Watertown Square and the more adequate provision for the steadily increasing traffic by the establishment of the new building lines as recommended, the completion of the clearing and improvement of the triangular park, the change in the outlet of Spring St. and the relocation of the car tracks. The exact character of these proposals can better be appreciated by reference to the plan submitted.

Spring St. at present comes into the Square at a most inconvenient point and tends unnecessarily to congest Main St. traffic. To divert it as we have recommended would, we believe, prove of decided advantage. We have indicated on the plan a method of taking care of the service requirements of all existing buildings. The section of Spring St. that we advise vacating could be built over in the future, or developed as an attractive shopping arcade.

The Main Thoroughfare diagram submitted as part of the local survey brings out clearly the importance of Watertown Square as regards the traffic lines that pass through Watertown. Practically all vehicles bound to Boston on the north side of the river, as well as most of the cross traffic between Cambridge and Newton which is considerable goes through this intersection. This centering of the traffic gives to Watertown Square peculiar prominence, and has caused it to become an index of Watertown. Moreover, this Square has long ceased to be merely a town center. It is an important focal point in the whole Metropolitan District. An examination of the map of Watertown in its relation to the circulation problems of the district and the town will make clear that no other intersection in Watertown, now or in the future, can compete in importance with Watertown Square. While the Square is not geographically the center of the town, it is the permanent center of business, traffic and interest, and very close also to the center of population. The three most populous eunmeration districts all abut on the Square, and the center of population as located from the government figures is within a block or two of the Main St. Mt. Auburn St. corner.

The construction of a new town hall in Watertown has been under general discussion for decades, and definite plans of merit have been presented and considered for at least seven years. The present town hall dates from 1850, and although creditable in its day, it has long since outlived its usefulness, and the site is not suitable for a new municipal building. The time for Watertown to decide has come. Action should be farsighted. It should be based upon a comprehensive plan and the adoption of a definite program for carrying out the plan logically, step by step, to a conclusion. A comprehensive program should include appropriate sites for the town hall and other public buildings, the establishment of a permanent and satisfactory layout for the entire Square, other necessary street changes leading into the Square, the consideration of more remote but related town planning problems, and the voluntary action of property owners in and about the Square with a view to the gradual improvement of the architecture of the business blocks.

The opportunity of Watertown to carry out at this time a substantial, successful and creditable piece of public work is quite unusual. It can be done now without burdensome expense, and will unquestionably bring large returns in practical convenience, higher property values, increased taxation and in civic pride. Watertown, like most other places of its size, stands in need of town planning. There are many important unsolved problems of streets, zoning, playgrounds and parks, housing, etc. Good work has already been done by the local Planning Board, and its report of 1914 is an admirable outline of the kind of practical services that town planning could render. The call now is to put recommendations into effect. No better start could be made than with the town hall, a project that should have the interest and backing of all citizens.

School for Inspectors on Asphalt Work

As a means for qualifying its inspectors for the inspection of bituminous paving the North Carolina State Highway Commission through its Division of Tests and Investigations has established a short course in bituminous laboratory and plant instruction. The course is necessarily a short one and consists of taking the men into the laboratory for about a week to learn the different tests of the materials used and to attend lectures by the supervisors of this type of construction. After the laboratory and lecture courses are over, the men are taken to the asphalt plant for instruction in the duties of the plant inspector and then on the road for instruction regarding the construction methods to be used.

The men for this work were secured mostly from the different districts into which the work of the Highway Commission is divided. The number of men from each district is proportional to the amount of this class of construction to be carried on. This will allow the men to be located in the same district they came from and the only need for any change would be in the demand for emergency inspection from another part of the state.

To allow the most efficient instruction to be given within the allotted time, it was found necessary to divide the student inspectors into two classes. The first class reported Feb. 20 and the second Feb. 27.

The subjects taken up consisted mainly of the following:

1. Qualifications of plant inspectors
   Qualifications of paving inspectors
2. Responsibility of inspectors
3. Sampling raw materials.
   Sand
   Stone
   Filler
   Asphalt
   Detail of methods for each and practical demonstrations with emphasis on the necessity for careful sampling of materials.
4. Testing raw materials in the field
   The men to do all the testing of the various materials until they are thoroughly familiar with the work
5. Asphalt plant construction
   Details of construction and operation of plants and emphasis on the various parts of the plant equipment which require careful inspection.
6. Asphalt specifications:
   Sheet asphalt wearing surface
   Bituminous concrete-fine aggregate type
   Bituminous concrete-coarse aggregate type
   Bituminous macadam-penetration method
7. Measurement and control of proportions
8. The calculations to secure the best mixture from available materials.
9. Explanations and performance of the various field tests for determining the voids, etc., in materials
10. Sampling the various types of mixtures
11. Control of temperatures at the plant
12. Characteristics of the different bituminous mixtures.
13. Care of testing equipment by the inspector
14. Co-operation between the plant and paving inspector.
15. Co-operation with the contractor
16. Fluxing refined asphalt at the plant
17. Dispatching from the plant
18. Reports
    The preparation of complete reports, cost data, and keeping of plant records.
19. Preparation of base course.
20. General methods of construction
21. Sampling on the road and check samples

Steel Turntable for Road Builders

A time and labor saving turntable for road builders is illustrated herewith. The construction is entirely of structural steel except the cast iron rollers equipped with roller bearings and the road skids or runners which have steel plate shoes. A pair of runways mounted on light wheels make up the turntable, which travels on a circular track. The track is attached to the skids or runners for ease of portability. The turntables are made in four sizes, for trucks from 1-ton to 5-ton or heavier capacity. The turntable for the 1-ton truck has 13 ft. long, 9 in. wide channel runways. The height of the runway above grade is 8 in. and the diameter of the circular track is 10 ft. This turntable is manufactured by the Western Structural Co., Moline, Ill.

Portable Turntable for Road Construction.

Float}Bridge for Concrete Road Construction

On many concrete paving jobs it has been found that a final belting some little time after the pavement has been struck off, tamped, and surfaced, does much to prevent hair cracks and also gives a better surface. Time usually does not allow the finishing machine to go back and do this final belting, and it was primarily for this work that the float-bridge illustrated below was developed. The float-bridge is a hand operated belt float and substantial bridge combined. One man operates the lever which moves the belt back and forth across the pavement, at the same time automatically advancing the machine a little with each stroke. The traction mechanism can be instantly thrown out of gear so that the float-bridge can be pushed forward or backward. The belt can be raised off the pavement and is automatically held up until released.

Lakewood Bridge Float

Machine Loading of "Red Dog" for Road Resurfacing

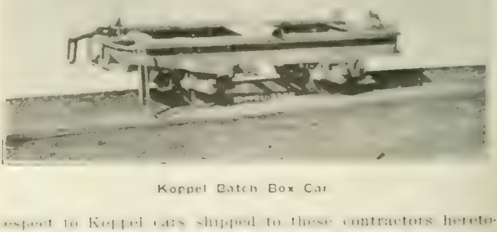
In some parts of Pennsylvania a material known as "red dog," a waste product of the coal mines, is used for road surfacing. The culm from the mines is piled in large banks and with it is mixed a certain amount of coal which often catches fire from spontaneous combustion and burns for a long period. This burning transforms the culm into material resembling slag from a blast furnace and this is called "red dog" because of its burned-out red color. This material is difficult to handle because of its unevenness in quality. In some spots it is soft and powdery, in others hard. The accompanying illustration shows a method of excavation used in Washington County for getting out this material. When the machine was put to work it was understood that blasting was to be done ahead of the loader. The blasting method proved unsatisfactory on account of the variation in material and the loader was finally jammed into the bank and did its duty just as though it were in a gravel pit.

Barber-Greene Loader Handling "Red Dog."

F. H. Hixson, in charge of the machine for the Washington County Commissioners, states that he has been able to load 280 to 300 tons a day direct from the bank. After several miles of county road had been resurfaced several of the townships and boroughs contracted for the use of the loader at a fixed daily charge for the machine and operator. In this work the machine has handled a total tonnage of 12,501 tons.

New Batch Box Car

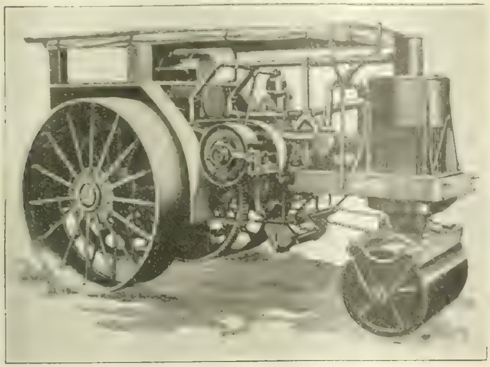
The accompanying illustration shows a new batch box car supplied for this season's work to Aaby & Maturi, of Chisholm, Minn., for the construction of a concrete road running partly alongside of the Duluth & Northeastern Ry., and touching this railroad at Martin Siding, Minn. The car is constructed for carrying two batch boxes, each containing 33 cu. ft. capacity. The construction of these cars differs in respect to Koppel cars shipped to these contractors heretofore due to the locking device which does not permit uncoupling without removing the pin, and the special V-shaped construction separator for the batch boxes which runs crosswise on top of the car. The underframe is made of heavy 6 in. ship channel steel. The wheels are cast steel 14 in. in diameter. The bearings are Koppel double spring suspended caged design. The brake construction is foot operating and acting on all four wheels.



Koppel Batch Box Car

New Road Roller Attachment for Tractor

The accompanying illustration shows the new road roller attachment for Avery road tractors. The road roller has the same wheel base as the Avery tractor with the front wheel. The roller sets directly under the front end of the machine in place of the front axle. The tractor will turn around as short with the roller as with axle. The turntable is mounted on ball bearings. The tractor with the roller is 9 ft. wide and has an average pressure per square inch on the road surface of 175 lb. This road roller attachment can easily be removed in less than an hour's time and wheels can be put on the machine for use in hauling and other jobs that may be required of a tractor.

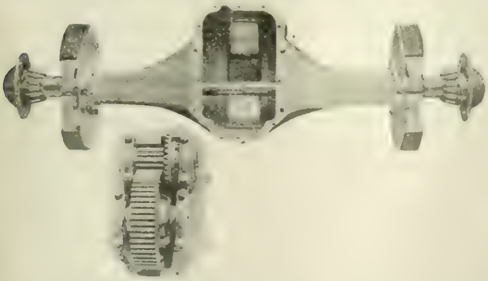


Avery 45-65 HP. Road Tractor with Road Roller Attached.

The Titan Central Double Reduction Truck Axle

A truck axle developed especially to meet the extreme conditions of sub-grade hauling of the road builder has been brought out by the Titan Truck Co., Milwaukee, Wis. The important features of this rear axle design are the gear reduction driving and full floating carrying principles, and the banjo housing. The one-piece banjo steel housing forms a continuous and unbroken double bridge construction from spring pad to spring pad, offering the greatest possible resistance in both upward and downward directions to road shocks. Under the full floating principle the load strain is entirely separated from the driving members, so that overloading and road shocks, and twisting can in no way cramp or bind the gears or driving elements.

All driving gears are assembled in a central head, this unit including gears and bearings, operating entirely in a bath of oil, and is self-contained. This is stated to insure aabsolute perfect alignment and quietness at all times, because of the full floating construction of the load carrying element. The shafts can be taken out without removing the wheels; the head itself can be taken out by the removal of four large bolts and placed on a work bench, and worked at in the light and with cleanliness. The power reduction is had through a set of wide faced bevel gears, and wide faced spur gears, which operate in a bath of oil.



Titan Central Double Reduction Axle.

Machine Loading of Trucks in Snow Removal

A mechanical loading machine was employed by one of the contractors in the Mott Haven District of New York City in snow removal work following the storm of Feb. 15 last. The machine was used in loading trucks from high snow piles in important streets. This particular snowfall was a combination of rain, sleet and snow, and was followed by a hard freeze. The snow piles were unusually difficult to handle, as they were frozen and had to be broken down by hand. Had the fall consisted merely of snow, this additional labor of breaking down the piles would not have been necessary. With four men breaking down the piles and one machine operator, a speed of one truck of 7.7 cu. yd. capacity every 2½ minutes is stated to have been not at all unusual, this including the time for getting the loaded truck away and placing the empty one. The operating cost, assuming that half the time is used up in moving the machine, and the average performance 1½ cu. yd. a minute, or 720 cu. yd. in an 8-hour day, is stated to have been as follows:

Haiss Loader in Snow Removal Work in New York City.

Gasoline, 15 gal. at 28 ct	$ 4.20
Operator	6.00
4 laborers	16.00
	$26.20

or about 3.65 ct. per cu. yd. The machine was designed and built by the Geo. Haiss Mfg. Co., Inc., of New York.

Instrument for Determining Truck Loads

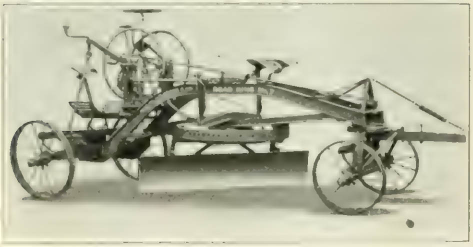
A portable weighing instrument, designed primarily for use by state and county officials for conveniently weighing trucks that are suspected of being overloaded is illustrated. Each loadometer has a screw jack mounted on a plunger which operates in an oil filled cylinder. By jacking up the truck with these instruments the weight is transferred to the instrument and the plunger indicates the pounds weight on a high pressure gauge connected to the oil chamber. The bodies

Checking Up Load of Truck with Loadometer.

of these instruments are of special aluminum alloy and the total weight of one loadometer is 40 lb. The loadometers are used in pairs in some states and counties, and in other places, in order to save time, four constitute a set.

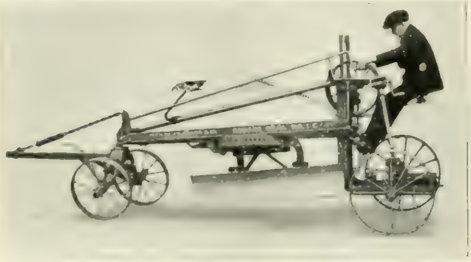
Two New Graders

Two new adjustable leaning wheel graders have been placed on the market by J. D. Adams & Co., Indianapolis, Ind., both of which are claimed to be particularly practical for road maintenance as well as street maintenance purposes. The Road King No. 7 is a general purpose machine that is strong enough and heavy enough for moderately heavy ditching and grading and yet light enough for general maintenance purposes. It has a 7 ft. blade and is designed for use with 6 horses or 10 to 18 H.P. tractor. Since it may be used either with horses or tractor it is furnished with horse equipment or engine tongue or both, as desired. The machine has all of the conveniences and adjustments of the larger Adams graders. All of the controls are within easy reach of the operator's seat from which all adjustments can be made while the machine is in motion and without the loss of a moment's time.



Road King No. 7 Grader.

The Square Deal No. 1-C was designed to meet the demand for a leaning wheel grader heavy enough to do light ditch work and light enough to serve as a 2-horse surface grader. This machine has all of the adjustments and efficiency of the larger Adams grader. All adjustments are easily and quickly made. The front and rear wheels are leaned independently as required by two cranks. The blade is raised and lowered by quick-acting worm and gear mechanism which affords positive and accurate blade adjustments. The frame is shiftable on the rear axle which enables the blade to cut well outside of the line of wheels on either side. The blade, of course, is reversible and is quickly set and locked at any desired cutting angle. The blade also has several pitch adjustments to suit the work being done.



Square Deal No. 1-C Grader

The Ideal Section of the Lincoln Highway.—Plans have been received by the U. S. Bureau of Public Roads for the "ideal section" of road to be constructed on the Lincoln Highway in Lake County, Indiana, during the coming summer. The designers of this road intend to produce in it their vision of what the main highways of the country must be in the future. The plans submitted to the State Highway Department of Indiana show that the section will be nearly 1⅓ miles in length and will be placed in the middle of a 100-ft. right of way. The roadway is to be 40 ft. wide and provision is made for the use of concrete, bituminous concrete or brick sections with 5-ft. gravel shoulders on each side. Each type of surface is to be of a thickness calculated to withstand heavy traffic. Night travel will be made safe by electric lights 35 ft. above the roadway and at suitable intervals on one side of the road. All electric wires will be underground. For pedestrians a 5-ft. gravel sidewalk will be placed in one of the 25-ft. strips of parking which are to be on each side of the road, and the parking will receive effective landscape treatment. It is not thought that present traffic justifies the width of roadway to be built, but rather it is intended as an object lesson for the future, and the traffic studies to be made on it will be valuable in settling many questions as to the relation of traffic density to road width, the best methods of traffic regulation, and other problems that are becoming more important each year. Federal aid will be granted on this highway at the rate of $20,000 a mile.

Wider Highway Tendency Shown in Road Building.—Of 6,500 miles of completed Federal-aid road for which statistics have been collected by the U. S. Bureau of Public Roads, one-half has been constructed of 16 and 18 ft. width, 25 per cent of a greater width, and 25 per cent of a less width. As would be expected the wider roads have been constructed largely in the more populous States, although some of the less populous States are building wider roads for the main highways. There is a general tendency, it is said, to build wider roads to meet the needs of the constantly increasing traffic, as shown by the 25 per cent of the mileage over 18 ft. in width, 7 per cent being 24 ft. or wider.

Personals

H. E. Hawkins, city engineer of Eldorado, Kans., has been appointed city manager.

R. S. Hummel has been appointed chief of the recently established Bureau of Street Paving of the Department of Public Works of Richmond, Va.

Benton Anderson has been elected city engineer of Clinton, Ia.

Francis Victor du Pont has been appointed a member of the State Highway Commission of Delaware. He is a graduate of Massachusetts Institute of Technology.

W. A. Van Hook, cost engineer of the Bureau of Valuation of the Interstate Commerce Commission, formerly assistant district engineer of the central district, has resigned to become chief engineer of The Roberts-Pettijohn-Wood Corporation, accountants and engineers, of Chicago.

S. H. Kintner, who is well known for his research and engineering work in the development of radio apparatus, has been appointed manager of the research department of the Westinghouse Electric & Manufacturing Co., succeeding C. E. Skinner, who has been made assistant director of engineering in the Westinghouse Company. He will be located in the research laboratory building near East Pittsburgh, Pa.

Obituaries

John P. Agnew, a well known contractor of Chicago, died March 23 at his home, 5409 Calumet Ave., that city, aged 61.

Harvey E. Grace, vice-president and treasurer of the William Grace Construction Co., Chicago, died Monday, March 26.

Martin Nelson, assistant engineer of the Foundation Co., was instantly killed March 23 at Watts, Calif., when he stepped from a Pacific Electric car and onto the next track where another car was passing at that moment.

Harry P. Nawn, president and general manager of the Hugh Nawn Contracting Co., of Boston, Mass., died March 28 at Gilboa, N. Y., where he was supervising the construction of the Gilboa Dam of the New York City water supply.

Industrial Notes

The Elgin Sales Corporation has moved its Chicago offices to [illegible] South La Salle St.

The Black & Decker Mfg. Co. has moved its Cleveland office from 6225 Carnegie Ave. to [illegible] E. 22nd St. Dan Paul is in charge of the office.

The Federal Motor Truck Co. announces the establishment of a factory branch at San Francisco with a completely equipped sales and service plant at [illegible] Post St.

W. C. Allen, former manager of the Black & Decker Philadelphia branch, and subsequently special representative, has been made branch manager of the Black & Decker Chicago territory, which takes in the states of Wisconsin, Illinois, Missouri, Iowa, Minnesota and North Dakota.

The Lakewood Engineering Co., Cleveland, O., announces that the Contractors Trading Co., Inc., [illegible] Fulton St., New York, will handle its building construction equipment exclusively. Geo. H. [illegible], formerly with the Lakewood Engineering Co. as sales manager, and Lloyd Wilson of the Lakewood Engineering Co. is associated with them as factory representative.

The Orton & Steinbrenner Co. of Chicago and Huntington, manufacturers of locomotive cranes, clam shell and orange peel buckets and coal crushers, have made arrangements with J. Ross Bates, formerly connected with Wonham, Bates & Goode Trading Corporation of New York and Boston, to represent them in the New England States and New York City. Mr. Bates has offices at [illegible] Liberty St., New York City, and [illegible] School St., Watertown, Mass.

A. P. Blackstead, formerly chief engineer of the Camden Iron Works (R. D. Wood & Co.), Camden, N. J., and prior to that hydraulic engineer with the Henry R. Worthington Co., New York, has joined the engineering staff of the Dayton-Dowd Co., manufacturers of centrifugal pumps and approved underwriters' fire pumps. Mr. Blackstead has had a broad experience on centrifugal pumps covering a period of over [illegible] years, both in this country and abroad. He recently returned from Europe, where he spent six months studying conditions and investigating recent developments in hydraulic engineering.

Waterworks and Hydraulics Monthly Issue

ENGINEERING AND CONTRACTING

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Management and Office System

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What Do Daily Paper Editors Know of Economics?

There is more discussion of political matters by the editors of daily papers than by any class of men other than politicians. What is of vastly greater importance is the fact that editors daily talk to, or at least at, audiences. They are, therefore, the most important teachers of political economics. What are the qualifications of the average editor to express opinions on economic matters? Judged by the daily papers that come to this office from every large city in America, there is not one editor in ten who has carefully read a modern treatise on political economy, and a still smaller number who have read a single book on business economics. Yet rare is the editor who is not ready to express a very positive opinion on any economic matter that seems to him to be of public moment.

Is it this morning's decision of a state public utility commission on telephone, or gas, or street car rates? Your average editor is prepared to pronounce upon it in tomorrow's paper—or even in this afternoon's edition. It matters not to him—and he rarely knows—that weeks of work were involved in hearing and reading the testimony on the rate case. The editor can tell you without securing any of the testimony that the commission in its decision was entirely wrong.

Is it a question relative to a tariff? The editorial answer is ready before the question has been fully framed. He will tell you that the prosperity of America in the past has been mainly due to protection; and that more than ever now is it desirable to shut out the products of "cheap foreign labor." It rarely occurs to him that if America is to sell to foreigners, foreigners must sell to America; or if his economic knowledge compasses this much of the elemental principles, still he is apt to deny the wisdom of applying the principle at this time or in this particular case.

Is it the cause of hard times? The editor is usually "there" with a reason—"overproduction," some acts of the Federal Bank board, the depreciated currency of Europe, labor troubles, or what not. Listen to this specimen from one of the largest of daily papers:

"If the coal strike and other labor troubles could be adjusted with little delay, the country's industrial situation would soon be as satisfactory as a normal home market can make it. Foreign trade would still remain a problem to be solved, for full prosperity is out of the question without a constantly increasing export trade to take care of the growing surplus of American products."

Full prosperity, this editor asserts, is out of the question without disposal of our surplus abroad. This is an old belief, but one that has never been established as being true. On the contrary there are many facts that controvert it. In the first place in normal times less than 10 per cent of our annual produce is shipped abroad, and in exchange we receive almost an equal amount of foreign produce. There is unquestionably an economic gain by the exchange, but it is probable that the gain does not exceed 30 per cent of the total amount sold. If so, 30 per cent of 10 per cent, or 3 per cent represents the annual net gain resulting to America from its foreign business in normal times, calling the entire annual business 100 per cent. In any event, the gain from foreign trade is normally a pitifully small part of the total business.

Put differently, if instead of exporting or importing anything, America were to depend entirely upon its own resources, the economic loss would probably not annually exceed about 3 per cent of the gross value of all our products. It is true, of course, that a sudden and great drop in exports upsets important industries, and that the effect is felt throughout the nation. But a nation soon adjusts itself to the new conditions and the ultimate effect is very slight.

Those who talk of the necessity of securing a foreign market for our surplus, ignore the fact that if we are producing too much of a given class of thing, the remedy is to curtail its production and to divert men and capital into other fields. This is a slow process, it is true, but it is the process by which the American people have reached the point where they are now consuming five times as much wealth annually per capita as they did a century and a quarter ago. We are not referring to wealth in dollars of different buying power, but to wealth expressed in dollars of the same buying power. The "real wage" (not money wage) is now five fold what it was in 1800. The per capita surplus production in 1922 is 400 per cent as compared with the total production in 1800. Are we sending this surplus abroad? We are not sending 10 per cent of it abroad, and for what we do send we are getting a quid pro quo in foreign goods.

It is the most puerile of economic sophistry to talk of American prosperity being dependent on a foreign sale of our surplus, yet we see this sophistry in our daily papers year in and year out, announced with the utmost assurance by writers who evidently think that no one would dare dispute them. Their very assurance makes it clear that they are not readers of scientific economics, for if they were students of economics they would realize that they must defend the propositions which they now regard as needing no defense.

Our professors of political economy haven't made a dent in the average editorial brain as yet. Perhaps engineers may accomplish what those professors have failed to do.

Why Do It Like the Other Fellow?

The account in this issue of Engineering and Contracting giving details of the design and construction of a low head conduit in the water supply system of Tacoma, Washington, illustrates a character of saving too often overlooked. In this instance a consideration of the low head and the fact that the lines were for emergency operation only, lead to a radical departure from ordinary types, with a very substantial saving as a consequence. Economy of construction was studied most carefully, and out of the studies came the conclusion that a concrete conduit of U section and flat top would supply the operating requirements of the case more cheaply than would any other.

What was there of significance in such procedure and conclusion? Merely this: that with the circular section all but universal for pressure conduits, jobs of such moderate size (presumably the conduit was to cost in the neighborhood of $40,000) frequently fail to bring out any really original thinking. With a first grade project, running into millions of dollars, we expect the exercise of first grade "engineering ingenuity," but with an undertaking of the modest proportions of this Tacoma job, careful and economical work along well known and established lines is often all that is asked.

If this were an isolated case, its lesson would not be important. As it is far from isolated, it serves as an excellent reminder of two things—the benefits which proprietors may derive from the employment of genuine engineering talent instead of more technical skill; and the opportunities ever present to the engineer who seeks them openmindedly. For the man of imagination and energy the opportunities are manifold.

In the possession of some men knowledge is a live thing: for others it is dead. When live, it stimulates the never-ending effort to which all advancement is due: when dead it is but a tool like a shovel or a steam engine. Why merely "do it like the other fellow"? Why be content with a dead knowledge? Such for centuries, was a great part of the knowledge of Asia and to a lesser extent, the knowledge of Europe. Men did that which always had been done, and in the way it always had been done, and thought they could do no better. No American desires to be classed with the Asiatic or with the European of a dead age; yet through a lazy following of precedent many Americans are very close to such a position.

Still, there is an opposite extreme which, if less common, may result in great evil. The man who cannot or will not learn the lessons of the past may invoke disaster where his ultra-conservative brother but accepts stagnation. Fortunately such cannot rise far in the practice of engineering, although a too great readiness to experiment or an overconfidence in judgment unbacked by proof are related faults not unknown in the profession. Truly the engineer requires a fine balance of qualities.

There is, we fear, an occasional overlooking of what should be an obvious grouping or classification of problems. The first group is composed of major problems for which high talent is needed without question. To the second, or intermediate group belong such problems as the one here mentioned. They are worthy of original thinking but they do not always get it. The third group includes only detail or distinctly minor problems, which do not warrant extensive studies, and are to be met by the simplest and most direct of standard means. Only a novice, and a thoughtless novice at that, will spend valuable time designing a structure of a few dollars cost when the requirement can be met by a standard and easily procurable article.

Why Construction Should Not Be Postponed

During the last six months of 1921 more long time bonds for public works were sold than during any previous period of twice that length. Since such bonds are sold well in advance of the construction that they cover, it is evident that the year 1922 will break all records for public works construction. Interest rates on such bonds have declined at an astonishing price during the last year, partly because of the business depression and partly because such bonds are exempt from income taxation. No public work need now be postponed because of high interest rates.

There is still some talk about "going slow on" public works until freight rates and prices come down, but students of price and wage levels are now pretty much in accord on the proposition that price and wage deflation has nearly, if not entirely, run its course.

Although freight rates are about 75 per cent above the pre-war level, there is no likelihood that an average reduction exceeding 10 per cent will be made for several years. Such a reduction would bring freight rates to a point about 60 per cent above the pre-war level, which is about the present excess of the cost of living over its cost in 1913. To bring even a 10 per cent reduction in freight rates will require a reduction of fully 20 per cent in the wages of railway employes, if railways are to earn 6 per cent on their invested capital. If they are to earn 6 per cent on their present cost of reproduction less depreciation, freight rates will have to be raised. All in all, it is quite as likely that freight rates will be 10 per cent higher five years hence as that they will be 10 per cent lower.

For 80 years average wages in America have been closely proportional to per capita money. Taking 10 years' averages (so as to eliminate fluctuations, due to "good" and "bad" times) the average wage has been almost exactly proportional to the average per capita money during the past ten decades. Per capita currency in America is now 50 per cent. and per capita gold is 80 per cent above the amount in 1913. With the revival of business paper money will increase, so that in all probability the increase in per capita currency will approach or even exceed the increase in per capita gold since 1913. Wages will follow the per capita money, unless 80 years of wage history are departed from. Therefore wage levels will probably be higher two or three years hence than they are today.

Two and a half years ago the writer testified in a federal court in Texas that he believed that prices and wages would fall, but that the fall would be arrested when a level about 60 per cent above the 1913 was reached, and that thereafter the decline, if any, would be very gradual. This prediction was based on the per capita level of money, and the events have thus far justified the prediction. There were many who at that time believed that price and wage levels would not recede. There were others who predicted a speedy decline to pre-war levels. Today after a year of stationary wholesale price level (average of 326 commodities), it is apparent that price deflation has run its course; and the prophets of continued decline to pre-war levels have almost ceased talking. We are now on the first stages of rising wholesale prices in most lines. No one can tell how long the rising period will continue, but there is little doubt that it will last until the wholesale price index reaches fully 160, or 60 per cent above the 100 per cent level of the year 1913.

An Explanation

To the Editor: In the letter appearing above my signature in the March 22nd issue of Engineering and Contracting the sentence: "In this state the majority of engineers are engineers in name only; who have not even a high school education," is likely to be misinterpreted. The sentence was intended to apply to conditions before the recent enactment of an engineer's registration law, when persons not distinctly engineers (such as land surveyors, electricians, plumbers, contractors, manufacturers' representatives, etc.), styled themselves engineers. It was unfortunate that the above sentence was used alone. If I had known my letter would be published I would have been more careful to explain the meaning of the sentence. I trust, therefore, that you will allow me space to correct any false impression that may have been created by the sentence.

Raleigh, N. C. HARRY TUCKER.

Scientific Research as a Career

Some interesting points on scientific research are given by Dr. W. R. Whitney, Director Research Laboratory of General Electric Co., in the February Wisconsin Engineer, from which we quote the following:

In 1,200 American industrial plants and many college and government laboratories, more than 10,000 men and women trained to be insatiably curious about the 90 odd elements which compose everything today are discovering new materials, new methods and improvements over the old. They are the country's industrial research workers. They fill the ranks of a profession whose value to industry is becoming of increasing importance.

Research is not new. It has been going on in one form or another ever since early man began to experiment with this and that to learn how to make better clothes and more palatable foods and more effective tools and weapons. But modern science had to produce a vast number of highly valuable contributions to knowledge before its experimentation was accepted by industry as of real value.

However, a few triumphs such as the making of wrought tungsten and the creation of a score of entire new industries around cellulose compounds which research men hit upon, were proof enough of the scientists' worth to business. Well equipped laboratories for them to work in, and the freedom with which they delve into the unknown now attract more and more young men and women eager for a creative career.

The man who will be successful in research work must, however, be of more than average ability. He must possess interest and a broad imagination. Above all, he must be honest with himself—be interested in truth and not merely in proving or disproving a hobby. It is not necessary for him to be a phychologist. He should have a wide perspective and the ability to distinguish between the essential and non-essential in his work in relation to the practical applications of it. He should possess an inquiring mind and the ability to get at the meat or kernel of whatever he may undertake He must, in addition, know how far to push investigation. In other words, he must be practical. He should question everything, even common facts—taking nothing for granted. The questioning mind of Dr. Irving Langmuir who started an investigation to find out how oil spreads out on water, resulted finally in the ability to measure the size of molecules. Ingenuity is an important asset, as is also resourcefulness. The research worker must know facts about matter—call it physics, mechanics, chemistry, electricity, or what not. The more he knows about his own science, other things being equal, the more he will accomplish, and the broader his knowledge of other sciences, the greater will be his ability. Above all, the man must be interested. If interest is absent, he must forego the excitement and pleasure of research, for they will seldom come to him.

Research work is not confining in the sense that a man is anchored to a desk on a routine job like bookkeeping, for instance, for there is a mental freedom about it. It differs from other fields in that current output is proportionate to the sum of previous effort and to be pre-eminently successful he should possess a general physique above the average. At the same time physical make-up is relatively unimportant since there is always a field for activity if one has the necessary mental qualifications. A well balanced research man usually does not follow the example of Mr. Edison, who works without sleep, and so prolongs a useful life. Edison should be considered an exception, as probably most would-be emulators would have died from the exposure he has withstood.

The college trained man is more likely to succeed. Although a college training is not absolutely essential, it gives an acquaintance with facts that emboldens one to try things. Research can best be described by the word "trying." An A.B training might increase his pleasure in living, but does not necessarily make him a better research worker.

Mental vision and wide interests are the most valuable requisites. Familiarity with economics and the humanities helps to give a man a sense of proportion as long as they do not district him from his work. Many men have lost their own or patron's money because they were hypnotized, or possessed by some single idea, plan or invention which ordinary schooling could have corrected.

Contradictions of the laws of thermodynamics and the production of something from nothing are still on the wing. During the war, of the hundreds of thousands of ideas submitted only one-tenth of one per cent were worthy of even being investigated. Most of them were submitted by people who had received little or no schooling. Their will and wish was fine, but they had not had a chance at good education.

In short, a well rounded technical education is best and since physics and chemistry are fundamentals of research work, these should be emphasized. Whether or not a man specializes in any particular field makes little difference as there are probably equal opportunities in all.

After he gets his educational training he should go after a job where there is a definite opportunity to do research work with a minimum of routine. Private work at present offers better opportunity than government work. Colleges often form good stepping stones in a young research man's career because he learns there to do much with little and to appreciate the value of published information or "literature."

Water Power Resources of Canada.—The developed water power in Canada now totals 2,756,000 HP., according to a report of the Dominion Water Power Branch of the Canadian Department of the Interior.

The latest figures on the water power resources of the Dominion showing the available water power, the additional installations during the past year and the present total developed power are presented in the following table:

Province.	Turbine installation in H.P. On Jan 1, 1921.	Installed during 1921.	On Jan. 1, 1922.	Available 24 hr. power at 80% efficiency At ordinary minimum flow, H.P.	Dependable for 6 mos., H.P
British Columbia..	305,115	200	305,315	1,931,142	5,103,460
Alberta	33,187	....	33,187	475,281	1,137,505
Saskatchewan	. ...	....	....	513,481	1,087,756
Manitoba	83,447	13,800	97,247	3,270,491	5,769,444
Ontario	1,039,000	*173,650	1,212,650	4,950,200	6,808,190
Quebec	926,095	89,290	1,015,385	6,915,244	11,640,052
New Brunswick ...	21,180	9,000	30,180	50,406	120,807
Nova Scotia	34,073	12,875	16,948	20,751	128,264
Prince Edward Island	1,869	.. ....	1,869	3,000	5,270
Yukon and N. W. Territories	13,199	....	13,199	125,220	275,250
	2,457,165	298,815	2,755,980	18,255,316	32,075,998

*Includes two units in the Queenston Plant.

State Water Supply Commission Suggested for New Jersey.—Creation of a State Water Supply Commission of not more than three members, with broad powers and more or less complete control of New Jersey watersheds, is suggested as the best way to insure proper water supply to the metropolitan district in the northern part of the State in future years in the report of Allen Hazen, of Hazen, Whipple & Fuller, New York engineers, who have just completed an investigation of the State's water supply problems for the State Conservation and Development Commission. This procedure is necessary, it is argued, because of the difficulty of securing proper co-operation among municipalities, and because of the need for a comprehensive and properly thought-out scheme, taking into consideration future as well as present needs. The idea would be to have the State commission, whose members would be appointed for long terms and be of the highest type, take over existing sources of supply, and provide for additions as needed, in accordance with a definite plan. The commission would sell the water at wholesale to communities wanting the water. Rates would be fixed from year to year, and be sufficient to make the department self-sustaining.

Tri-State Water and Light Association Convention.—The Tri-State Water and Light Association of the Carolinas and Georgia will hold its 12th annual convention at the Chamber of Commerce Building, Spartanburg, S. C., April 19, 20 and 21. W. F. Stieglitz, Columbia, S. C., is Secretary.

A Page from Recent Waterworks Reports

Cost of Watermain Construction at Detroit.—During fiscal year 1921 the construction forces of the Department of Water Supply laid 745,000 lin. ft. of water pipe. The unit cost of this work, according to report of the Board of Water Commissioners for the year ending June 30, 1921, was as follows:

[illegible]	Size	Materials	Labor	[illegible] expense	Overhead expense	Total cost
[illegible]	[illegible]	$ [illegible]	$ [illegible]		....	$1.41
[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	$ [illegible]	$0.10	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]		.11	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	4.26
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Cost of Installing Water Meters at Detroit.—The following table from the last annual report of the Board of Water Commissioners of Detroit, shows the cost of installing meters during the year ending June 30, 1921.

Size	No.	Labor and [illegible]	Materials	Cost
[illegible]	[illegible]	$ [illegible]	$ [illegible]	$ [illegible]
[illegible]	[illegible]	[illegible]	9.81	16.68
[illegible]	[illegible]	[illegible]	13.71	16.88
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	113.61
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Cost of Meter Testing at Detroit—The 69th annual report of the Board of Water Commissioners of Detroit contains the following table showing the cost of meter testing for [illegible] in., for the year ending June 30, 1921:

Size	No.	Cost	Average cost per meter
[illegible]	[illegible]	$[illegible]	$ [illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	.7787
[illegible]	[illegible]	[illegible]	2.7100
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	.....

Cost of Repairing Meters at Los Angeles.—The following table from the 20th annual report of the Board of Public Service Commissioners of the city of Los Angeles shows the cost of meter repairing from July 1, 1920, to June 30, 1921, for Los Angeles, San Pedro and San Fernando Valley:

Size meter	No.	Labor	Material	[illegible]	Total cost	Average cost per meter
[illegible]	[illegible]	[illegible]	[illegible]	$1,342	$[illegible]	$1.51
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.99
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	741	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.48
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	.115
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Income and Expenditures for Maintenance of Hartford, Conn., Waterworks for 20 Years. The 67th annual report of the Board of Water Commissioners of Hartford, Conn., for the year ending March 1, 1921, contains the following interesting table showing the trend of water consumption, receipts for water, expenditures for maintenance and expenditures for construction, total and per 1,000,000 gal. for the 20-year period [illegible].

Year	[illegible]	[illegible]	Receipts from water rates Total	Per M. G.	Expended for maintenance Total	Per M. G.	Expended for ordinary construction Total	Per M. G.
[illegible]	[illegible]	[illegible]	$[illegible]	$[illegible]	$[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	$130,661	51.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	121,887	46.70
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	41.50
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	46.2[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	39.2[illegible]

1914	9.18	3.350	598,[illegible]	[illegible]	188,603	56.[illegible]	112,229	12.[illegible]
1915	9.[illegible]	3.440	100,214	[illegible]	1[illegible],082	50.7	158,560	46.[illegible]
1916	10.54	3,860	112,8[illegible]	[illegible]	1[illegible],936	46.6	182,513	47.[illegible]
1917	11.14	4.175	156,61[illegible]	[illegible]	266,460	[illegible]	133,451	32.0[illegible]
1918	11.8[illegible]	4.3[illegible]	[illegible]	[illegible]	253,[illegible]2	60.8	123,986	30.0[illegible]
1919	12.1[illegible]	4.43	[illegible]	[illegible]	248,[illegible]72	[illegible]	151,978	[illegible]
1920	12.8[illegible]	1.69	[illegible]	[illegible]	[illegible]	[illegible]	176,384	[illegible]

*Including $11,[illegible] for [illegible].

The report contains the following comments on the above figures: The amount of new building largely determines the expenditures for ordinary construction and therefore they cannot be compared from year to year, except in their relation to new building. Expenditures for maintenance do, however, bear a definite relation to the amount of water consumed and so are susceptible of comparison from year to year on the per million gallon basis. The expenditures per million gallons of water consumed have steadily decreased during the last four years in spite of constantly increasing prices of materials, wages, and the many little-realized things, such as the extension of improved pavement, which make waterworks operations more expensive. As this pavement is extended, more and more main pipe and services are included under it, and when repairs or renewals are made the work is much more expensive than formerly. New main pipes under asphalt cost at least $1 per foot additional, and each service in asphalt costs $25 to $50 more than a similar one in macadam or dirt street.

Cost of Water Main Construction at Hartford, Conn.—The following table from the 67th annual report of the Board of Water Commissioners for the year ending March 1, 1921, shows the average cost of main pipe work during the season 1920 compared with costs for the previous five years:

Size In.	Length laid 1920 Ft.	Labor	Material including transp.	[illegible]	1920 Total	1919 Total	1918 Total	1917 Total	1916 Total	1915 Total
4		$	$	$	$1.80	$		$1.20	$0.81	$
6	[illegible]	0.94	[illegible]	[illegible]	2.60	2.42	.	1.46	1.2[illegible]	
8	11,446	1.25	[illegible]	[illegible]	3.12	3.45	2.41	1.66	1.6[illegible]	
10	2,[illegible]70	1.38	[illegible]	[illegible]	4.53	4.72a	3.00	2.15	1.93	
12	265	1.31	[illegible]	[illegible]	5.43	4.1[illegible]	4.12	2.82	2.43	
16	....	....	....	....	9.55b	6.1[illegible]	4.92	4.[illegible]8	....	
	1[illegible]									

(a) Includes some [illegible]. (b) Two special bridge crossings. No [illegible].

The greater pipe installation costs of 1920 over those of 1919 are due to the increased cost of labor and materials during 1920. Labor cost was increased about 16 per cent. The average cost of cast iron pipe in 1919 was $58 per ton while in 1920 it was $73.50 per ton, an increase of $15.50 or about 26.8 per cent. The effect of this is realized when it is understood that the cost of pipe and fittings is about 74 per cent of the total cost of the work. The cost for labor and material on the 1920 work was:

Labor .... $[illegible] for 8 hours, 44 hrs. per week
Pipe .... [illegible] per ton
Specials .... [illegible]
Lead .... [illegible]

They Pay Their Water Bills at Haverhill, Mass.—The 10th annual report of the Board of Water Commissioners of Haverhill, Mass., for 1921, contains the following statement by the Water Register:

"For the fifth time I am able to report that every water bill sent out during the year has been settled."

Amounts of Water Wasted at Various Pressures.—A glance at the table below, which is reprinted from the 34th annual report of the Board of Water Commissioners of Dover, N. H., for the year 1921, shows how easily water is wasted under various pressures and at a rate of 23 ct. per 100 cu. ft.:

Diameter of opening	30 lbs. Cubic feet discharged per day	Value at 23 ct. per 100 cu. ft.	65 lbs. Cubic feet discharged per day	Value at 23 ct. per 100 cu. ft.	85 lbs. Cubic feet discharged per day	Value at 23 ct. per 100 cu. ft.
1/16 in.	155	$ [illegible]	167	$ .38	198	$ .45
1/8	613	1.41	667	1.53	760	1.74
1/4	2,4[illegible]	5.77	2,667	6.13	3,066	7.05
1/2	[illegible],867	2[illegible]	10,667	24.53	12,266	28.21
3/4	21,[illegible]	19.07	24,400	56.12	28,000	64.40
1	39,4[illegible]	90.[illegible]	42,667	98.12	49,066	112.85

Design and Construction of Novel Concrete Conduit

Unusual Design and Cement Gun Construction Produce an Economical Low Head Conduit

Details, Costs and Solutions of Special Problems

By W. A. KUNIGK,
Superintendent of Water Works, Tacoma, Wash.

The Water Department of the City of Tacoma completed during the summer of 1921 the construction of a built in-place gunite water conduit, which on account of some novel features both in design and construction, should prove of interest to many engineers.

Function of Conduit.—The gunite conduit replaced two wooden pipe lines of various diameters, and serves the purpose of collecting the discharge from 12 wells strung out over a distance of ¾ of a mile south of Pump Station "C," located at South 63rd and Cedar Sts. The conduit empties into a small reservoir at the pump station.

Quantity, Pumping and Measurement.—The wells are of the driven type, 12 in. in diameter and cased. Their average depth is about 135 ft., with a total yield of approximately 15,000,000 gal. per 24 hours, and a maximum yield per well of approximately 1,500,000 gal. per 24 hours.

The water is raised to the surface in these wells by a so-called air lift system, air being supplied from compressors located at the pump station through two pipes which are connected to the individual wells. In order to keep a close check on the yield of this system each individual well discharges into a concrete weir box where most of the air is liberated and the flow can be measured by ascertaining with a hook gauge the head over a sharp crested weir. From the weir box the water discharges into the conduit and is then conveyed by gravity to the pump station reservoir. Just before entering the reservoir the water passes through a screen chamber and then over a sand box where slight accumulations of sand are removed and the water is also chlorinated. From the reservoir the water is pumped into the high service district of the distribution system. All compressors and the pumps at this station are electrically operated and the station can be started at a moment's notice.

Character of Service and Operation.—This air lift well system is maintained by the Tacoma Water Department as an auxiliary supply, and is called upon in case of a break in, or necessry repairs to, the Green River gravity system which constitutes the principal source of supply for the City of Tacoma. It may also be used for the purpose of boosting the pressure from the gravity supply system during the sprinkling season of the summer months when the rate of demand at times equals or exceeds the rate of supply.

The intermittent operation of the well system, coupled with the fact that the pressure on the collecting pipe at any point does not exceed 10 lb. per sq. in., contributed greatly to the rapid decay of the old wooden collecting pipes, some parts of which were entirely decayed after about 10 years of service.

Design for Economical Construction.—The peculiar horseshoe cross-section of the conduit was decided upon with the idea of facilitating the application of gunite, permitting the cement gun nozzleman to do all shooting from alongside the ditch, with the advantage of eliminating the use of inside forms. Two sections were designed, the smaller section measuring 24 in. and the larger section measuring 36 in. across underneath the top slab. The semi-circular part of the small section is made of gunite 2½ in. thick, and increased to 4½ in. in thickness at the construction joints below the pre-cast slab. The bottom part of the section is reinforced with a single layer of American Steel & Wire Company's triangular mesh, No. 093 being used where the head was 6 ft. or less and No. 126 mesh being used where the head was from six to 23 ft. The gauge of the wire mesh around the corners was also varied in a similar way according to the head.

The pre-cast slab across the top was made of 1:3 cement mortar 1½ in. thick and reinforced with No. 126 mesh. These slabs were intended to carry only the weight of gunite during construction or the weight of a man temporarily while the top steel was being assembled and the top cover of gunite was being shot in place. The top slab was made of gunite 2½ in. thick, and was designed independently of the pre-cast slab. A maximum backfill of 5 ft. was assumed, and various heads up to 23 ft. were provided for in the reinforcement, water and backfill stresses being considered to act independently. The lower part of the top slab was reinforced with No. 093 mesh, and the upper part was reinforced with the same gauge mesh for heads of 6 ft. or less and with No. 153 mesh for heads from 6 to 23 ft.

No expansion joints are provided, and temperature stresses are taken care of by seven ⅜ in. round, corrugated bars spaced equidistant around the periphery and lapped 15 in. at splices. All gunite used in both small and large sections was of 1:3 mix, cement and sand respectively measured in loose volume. The gunite in the weir boxes and the pipe connections was of similar mix.

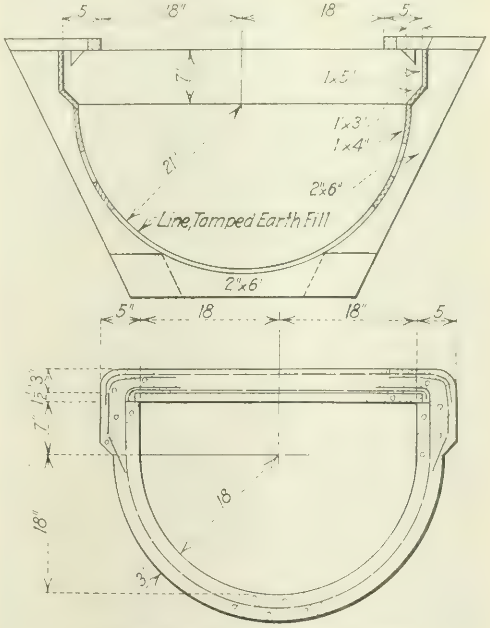

Fig. 1—Section and Forms of 36-Inch Conduit.

The semi-circular part of the large section of the conduit is made of gunite 3 in. thick and increased 5 in. in thickness at the construction joints under the pre-cast slab. This part is reinforced with a single layer of No. 093 mesh and an additional layer of No. 153 mesh is provided around the corners. The maximum head on this section is assumed at 6 ft. The pre-cast slabs for this conduit were made of the same mix and thickness and reinforced with the same gauge wire mesh as those for the smaller conduit. The top slab was made of gunite 3 in. thick and was designed for a maximum backfill of 5 ft., and for heads as stated before. The reinforcement consisted of two layers of No. 153 mesh placed near the top and bottom. The temperature stresses in this section are provided for by eleven ⅜ in. round, corrugated bars spaced equidistant around the section.

Unit Stresses.—The maximum unit stress for gunite in the top slab of the two sections was limited to 900 lb. per sq. in.

The maximum unit stress for the wire mesh was fixed at 16,000 lb. per sq. in. However, the exactly economic gauge of wire mesh could not be obtained and the next heavier stock sizes were selected. On account of the extra reinforcement around the corners the top and bottom sections were considered to act monolithically.

Lamp Holes and Manholes. The entire line south of the pump station is provided with alternate lamp holes and manholes at all points of change in grade or alignment as in sewer construction, so that any section of the line may be readily examined. With the exception of one lamp hole which was made of wrought iron pipe, all of these have been built of gunite 3 in. thick reinforced with wire mesh, shot from the outside over collapsible forms or over thin sheet metal forms left in place. All lamp or manholes are provided with galvanized iron hoods.

Weir Boxes.—The original plan was to build all weir boxes of expanded metal to be plastered inside and out with cement mortar, but this idea was abandoned after the first weir box had been built in this fashion. It was found that they could be built of gunite at a greatly reduced cost in a manner similar to that of the lamp or manholes, that is, over an inside collapsible form. On its inside each weir box is provided with a galvanized sheet iron baffle plate and a sharp crested weir. In the top slab is left a 12 in. diameter opening covered with a galvanized sheet iron hood to provide the necessary outlet for air.

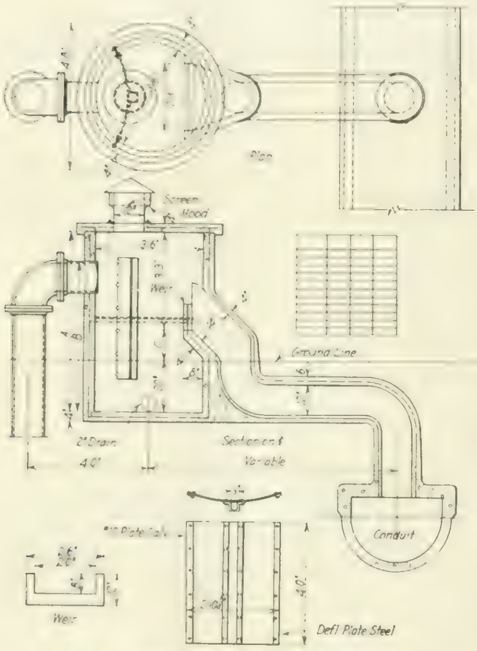

Fig. 2—Plan, Section and Details of Weir Box.

All outside exposed surfaces of gunite were left in their natural finish without troweling or brushing. They resemble very much the so-called stipple finish and have a pleasing appearance for this class of work. Two weir boxes were built 18 ft. above the ground on elevated concrete platforms in order to raise the weir crests above the elevation of the hydraulic gradient at these points.

Construction Plant. The cement gun outfit for this work consisted of one N-1 and one N-2 cement gun. The mixing plant consisted of one sand drier, one 4 cu. ft. gasoline concrete mixer and one rotating screen, all housed under a canvas roof. The cement guns were moved along as the pipe work was progressing. Usually about 400 ft. of pipe was built from one set-up of the cement gun, thus limiting the length of the material hose to 200 ft. When construction work began the mixing plant was set up near the pump station, and after about half of the pipe line had been built it was moved to a convenient place along the line about 1,000 ft. from the south end. In this manner all gunite material for the entire line was distributed from only two mixing stations. A 1-ton Ford truck took care of the hauling of this material to the cement guns, handling about 1 cu. yd. per trip.

Improvised Bending Equipment. The cutting and bending of the wire mesh was all done near the pump station, a homemade roll consisting of three 6 in. diameter wooden rollers covered with old belting and supported on a wooden frame in the shape of an equilateral triangle being used for the bending or straightening out. The upper roll was provided with a crank on one end and could be raised or lowered in a slot so that by passing the mesh between these three rolls it could be given the desired curvature required for the lower section of the gunite flumes, or could be straightened out as was necessary for the slab reinforcement of the upper sections. This device was found to be very simple and effective in taking care of the bending of all the wire mesh used.

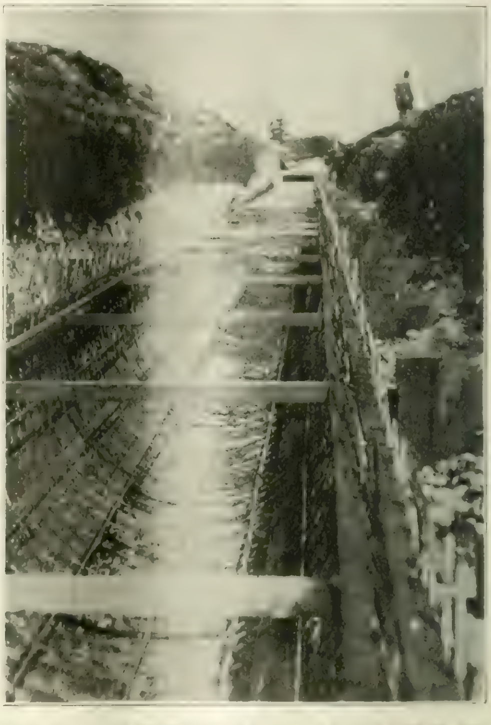

Fig. 3—Forms and Reinforcement for Lower Section of 36-In. Conduit in Place, Showing Braces and Molding Strips Which Form the Construction Joints.

Sand Drier and Screw.—The sand drier consisted of a 6 ft. by 10 ft. plate of 3/16 in. steel supported over a firebox and circulating duct built into the ground and lined with 1:3:6 concrete, connecting with a 10 in. sheet iron stack. For fuel, slabwood in 4 ft. lengths was used. The screen consisted of a 2 ft. diameter by 6 ft. long steel wire drum having four meshes to the inch. This drum was fastened to a central shaft by three spider frames with the shaft supported in boxing resting on a wooden frame in a slightly inclined position. The screen was operated by a small gas engine connected through a belt and bevel gear.

Air Drier. A very desirable piece of equipment for the cement gun work on this job was an air drier. On some previous work on which a cement gun was used by the Water Department during extremely wet weather considerable trouble developed on account of the moist air condensing in the air line leading to the gun. This condensed water would get in the bottom of the gun and mix with the cement and sand and choke up the feed wheel about every half hour, thereby, of course, stopping all operations. The writer came to the conclusion that if dry air could be supplied there should be no trouble in operating the gun regardless of weather conditions. An air drier was therefore made, consisting of a welded tank of No. 12 gauge steel, 20 in. in diameter, and 4 ft. 6 in. long, provided at each end with a 2½ in. pipe connection and at the bottom with a ½ in. pit cock and with a hand hole on top. Near the outlet end before it was welded a ¼ in. mesh screen of galvanized iron was inserted. This tank was filled through the hand hole with coke, and then cut into the air feed line near the cement gun with the pit-cock left slightly open for the purpose of blowing off the accumulating water. No trouble has been experienced by the writer in using the cement gun in wet weather wherever this simple device was used. The reduction in air pressure on account of the use of the air drier was negligible.

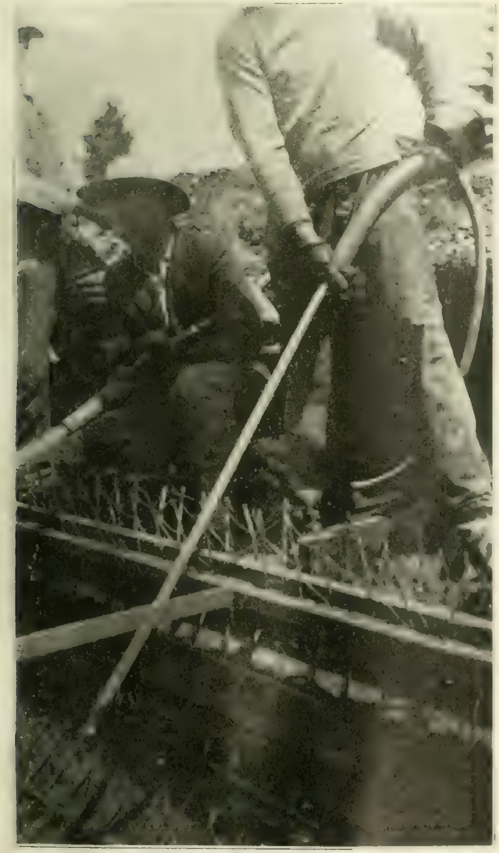

Fig. 4—View Showing Manner of Shooting Gunite In Lower Section of 36-In. Conduit. (Note Man With Air Nozzle Working Immediately Ahead of Cement Gun Nozzle Operator).

All pre-cast slabs were made in a temporary shed alongside the pumping plant on flat forms which were piled on top of each other, leaving about 1 in. of space between forms. This permitted the sprinkling of the slabs while they were curing and also provided for air circulation.

Organization and Method of Construction.—In constructing the gunite conduit it was desirable that as many operations as possible should be carried on simultaneously so as to reduce to a minimum the time during which the emergency water supply from Pump Station "C" would not be available for the city's use. The work was therefore laid out and carried on with the idea of keeping as much of the old collecting system intact as was possible without seriously interfering with the progress of the new work. The rate of progress was, of course, limited by the output capacity of the two cement guns which the Water Department had available for this work. After the work had been gotten fully under way the various operations were carried on as follows:

A crew of 20 to 40 men made the excavation, trimming the ditch to the required grade and line, and put in temporary crossings at all street intersections. Then followed a gang of from 2 to 5 men with a carpenter setting the forms in the ditch to grade. The forms consisted of girths spaced 4 ft. centers, sawed out of 2 in. by 6 in. lumber, lined with 1 in. rough boards of a cheap grade conforming to the outside form of the lower section of the conduit. The girths were all cut at the sawmill according to templates furnished, and the forms were assembled alongside the ditch in 12 or 16 ft. lengths. In setting the forms to grade and line in the ditch the lower quadrant of the circular section was left open as shown in Fig. I, the backfill of the quadrant was tamped to the required curvature, and the side were then backfilled to the top of the forms. A crew of two or three men would then follow to place and wire the reinforcement for the circular section of the conduit. After the steel was assembled the wire mesh was raised the proper distance above the bottom of the forms and fastened with nails to the molding strips which formed the construction joints. Following came the cement gun crew consisting of one nozzleman, one helper assisting in moving of the material hose, one man with air

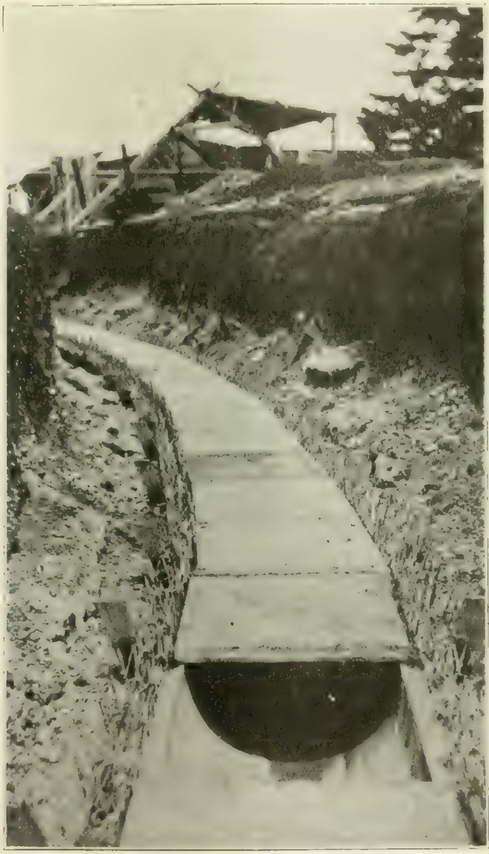

Fig. 5—Curve in 24-In. Conduit Showing Lower Section Complete With Pre-cast Slabs in Place. (All Curves Were Standardized So That One Template Could Be Used for all Slabs on all Curves.)

hose, one cement gun operator, and one helper feeding the gun.

Rebounding Sand and Cleaning Problems. For the shooting of the lower section, the N-2 gun was used. When starting on this work considerable difficulty developed in disposing of the rebounding sand which would accumulate in the bottom of the forms ahead of the gunite work and was hard to remove from between the wire mesh reinforcement. The nozzleman would stand alongside the ditch and shoot the side opposite him and then changing his position to the other side of the ditch to complete the half circle, he would find so much rebound accumulated that it was practically impossible to prevent sand pockets in the gunite. After some experimenting the following method of overcoming this difficulty was evolved. A ¾ in. air hose was connected to the main air pipe and fitted at the end with a 4 ft. length of ½ in. pipe hammered out at the discharge end to a flat pointed tip. This air nozzle was operated by a laborer immediately ahead of the cement gun nozzle, always keeping the reinforcement clean and ready for the application of the gunite.

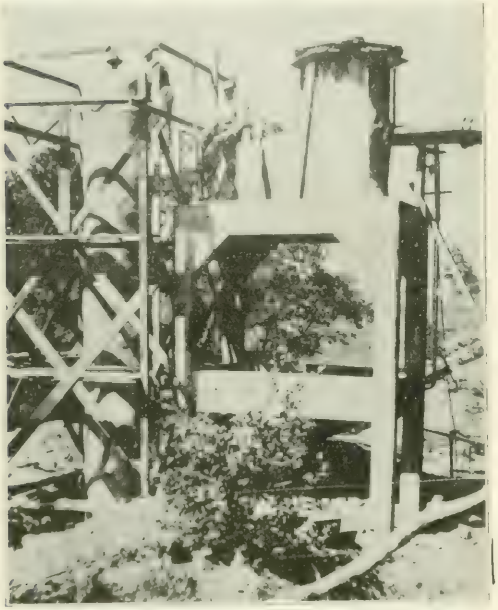

Fig. [illegible]—Weir Box on Concrete Pedestal With Gunite Standpipe at South End of 24-Inch Conduit.

The accumulating sand was disposed of by blowing it into the space below the open part of the form where the ground had purposely been kept somewhat below grade. About every 10 to 15 ft. of conduit the cement gun nozzleman would operate his nozzle with air and water only, thoroughly cleaning and wetting the forms ahead and also leveling off the sand below the reinforcement. In order to make the inside as nearly as possible true to line the nozzleman's helper would carry along a light wooden template conforming to the inside outline of the conduit. With this he would keep a close check on the work as it progressed, always pointing out to the nozzleman any slight variations in the gunite from the true line.

Finishing and Curing. Following the cement gun crew closely came a cement finisher and his helper. In order that the finisher might work close to the nozzleman a canvas mounted on a light wooden frame was always kept between the nozzle crew and the finishing crew. In this way the finisher was not bothered with flying sand which otherwise would have been troublesome on windy days. The finishing was done with a steel trowel after all surplus material had been removed with a straight edge by the helper. A very smooth surface was obtained in this way, equal in every respect to that of a pre-cast pipe. This surface was kept wet from four to six days and protected against the rays of the sun on bright days by portable canvas awnings mounted on 4 ft. by 12 ft. wooden frames. However, during the construction work considerable rainy weather was encountered which, of course, was conducive to producing a well-cured concrete. The cement gun crew and finishing crew would on such days work under canvas covers stretched over light portable wooden frames and practically no time was lost on this account except on a few days when the rain was accompanied by high wind.

Following the finishers came a crew of from two to four men who removed the molding strips which formed the construction joints and then laid the pre-cast slabs. These slabs were laid with the troweled side downward in a 1:3 cement mortar and were also joined endwise with a mortar joint, all joints on the inside of the conduit being struck off.

Top Construction. The pre-cast slabs were made of 1:3 mix, using in the sand all of the rejected material from the rotating screen. They were cast by a crew of three men in a temporary construction shed on three sets of oiled wooden platforms provided with collapsible frames. The wire mesh reinforcement for these slabs was held in place by a couple of No. 16 gage wires drawn through the frame. The upper side of all slabs was steel troweled as this was the side that was to come in contact with the water when the conduit was completed. Usually the slabs were kept wet for about eight days, but often they were taken out of the frames three days after they were poured and then stored, standing on end until used. Considerable trouble from breakage was anticipated by the men who were to handle the slabs, but not over seven or eight slabs were broken on the entire job, and some of these broke because they were dumped off the truck that distributed them along the line.

Following the crew placing the slabs came another small crew placing the reinforcement for the top slab. Then came the gunite crew shooting the top slab in place with an N-1 gun which has about 25 per cent less capacity than the N-2 gun, which was used in shooting the bottom. In shooting the top, great care was exercised in thoroughly wetting the pre-cast slabs and in making a perfect junction with the old gunite at the corners. Finally came the finisher and his helper, troweling off the top and taking proper care in protecting the green gunite.

The distribution of all the material for the cement gun, the forms, the reinforcing steel, the pre-cast slabs, etc., was handled by a 1-ton truck. On days when it did not rain the green gunite was kept wet by sprinkling and after 3 or 4 days was covered with about 3 in. of the excavated material which was then kept wet for another 4 or 5 days.

In joining the gunite work of consecutive days, the only precaution taken was that of running the end of a day's gunite work out to a feather edge over a distance of about 12 in. The next morning the new work was joined after a thorough cleaning and wetting of the end of the preceding day's work and not the slightest leakage has appeared at any of these joints.

Final Tests.—A working test was made 28 days after the last gunite was shot and only a few small damp places could be detected at the construction joints immediately below the flat slabs. The water was left standing in the gunite pipe for a number of days but no appreciable lowering of water level could be detected in the standpipes, and the conduit was then put in service. The conduit has now been in operation through one summer and one winter season, and has withstood temperature changes from 90 degrees to 10 degrees above zero without the slightest sign of distress.

Cost Data. The total cost of this construction work was $40,653.31, distributed over the different items as shown in the following statements:

[illegible] ft. of 36-in. conduit at $[illegible] per ft.	[illegible]
[illegible] ft. of 24-in. conduit at $[illegible] per ft.	[illegible]
Excavation, backfilling, [illegible] and [illegible] [illegible]	[illegible]
[illegible] boxes, [illegible] concrete [illegible] stands [illegible] [illegible], weir box [illegible] [illegible] [illegible] work [illegible]	[illegible]
[illegible] cutting, testing and [illegible] expense	[illegible]
Total cost of work	[illegible]

The wages paid for laborers, superintendents, etc., were as follows:

Construction engineer, per month	[illegible]
Sub-foreman on excavation and reclaiming of old [illegible] [illegible] of [illegible], per day	[illegible]
Carpenters, per day	[illegible]
Cement finishers, per day	[illegible]

Cement gun nozzle operators, per day	7.00
Cement gun operators, per day	4.75
Team and driver used in backfilling, per day	[illegible]
Laborers	4.75

The labor cost of the cement gun organization using one N-1 and one N-2 gun was as follows:

2 nozzle operators at $7 per day	$14.00
2 nozzle operators' helpers at $4.75 per day..	9.50
2 air [illegible] at $4.75 per day	9.50
2 cement gun operators at $4.[illegible] per day	9.50
2 cement gun operators' helpers at $4.75 per day	[illegible]
2 cement [illegible] at $7 per day	14.00
3 laborers [illegible] cement [illegible] and wetting [illegible] after [illegible] of pipe at $4.75 per day	14.25
5 laborers [illegible], mixing and screening material at $[illegible] per day	[illegible]
1-ton [illegible] at $4 per day	[illegible]
1 [illegible] each [illegible] time) at $4.75 per [illegible]	[illegible]
1 superintendent (1/2 time) at $7 per day	[illegible]
Labor cost per 8-hour day	$[illegible]

Daily quantities of gunite and labor costs per cu. yd. placed were as follows:

Gunite placed per 8-hour day	12.02 cu. yds.
Cost of placing per cu. yd.	[illegible]

Output of N-1 gun equaled 5.15 cu. yds. per day

Output of N-2 gun equaled 6.87 cu. yds. per day

The prices paid for material delivered at the site were as follows:

Cement	$3.20 per bbl.
Sand or gravel	2.75 per cu. yd.
Lumber, average price	18.00 per M ft. B.M.
Reinforcing steel, 3/8-in. corrugated bars	[illegible] per cwt.
A. S. & W. Co. triangular mesh	
No. [illegible]	[illegible] per 100 sq. ft.
No. [illegible]	[illegible] per 100 sq. ft.
No. [illegible]	[illegible] per 100 sq. ft.

The itemized cost per lineal ft. of the 36 in. conduit was as follows:

	Per lin. ft.
Forms (labor and material)	$[illegible]
Cement	1.12
Sand	[illegible]
Reinforcement (material only)	[illegible]
Reinforcement (labor of cutting, bending and placing)	[illegible]
Gunite (labor of placing)	[illegible]
Pre-cast slabs (labor and material)	[illegible]
Depreciation of plant and cost of air, etc	[illegible]
Cost per lin. ft. in place	$[illegible]
Cost of excavation, reclaiming of old pipe and backfilling..	1.70
Total cost per lin. ft.	$7.07

The itemized cost per lineal ft. of the 24 in. conduit was as follows:

	Per lin. ft.
Forms (labor and material)	$[illegible]
Sand	[illegible]
Cement	[illegible]
Reinforcement (material only)	[illegible]
Reinforcement (labor of cutting, bending and placing)	.34
Gunite (labor of placing)	[illegible]
Pre-cast slabs (labor and material)	[illegible]
Depreciation of plant and cost of air, etc	[illegible]*
Cost per lin. ft. in place	[illegible]
Cost of excavation, reclaiming of old pipe and backfilling	[illegible]
Total cost per lin. ft.	$[illegible]

*See text explaining low cost of air.

Depreciation Air Cost, and Gunite Quantities.—The cross-sectional area of the gunite in each conduit as built was approximately 10 per cent greater than the neat dimensions shown on the plan and was so taken in analyzing the cost of the gunite work. The principal reason for this was the open section of the forms at the bottom and also a slight increase in the thickness of the top slab. In considering depreciation a plant investment of $4,400 was charged against this work for a period of 3 months on the basis of 3 per cent per month. This gives a total depreciation of $396. In this equipment were included one N-1 and one N-2 cement gun with all the necessary material, air and water hose, one 4 cu. ft. gasoline mixer, one air-dryer, one sand dryer, one rotating screen with gas engine, canvas covers and awnings, fittings and necessary piping. The cost of air for the cement gun on this work was very small as it was furnished from one of the electrically-driven compressors at the pump station. The station attendant operating the compressor was not charged to this work, and power was furnished by the Municipal Light and Power Plant at 1/2c per KWH.

Conclusions.—From close observation during the progress of the work the writer draws the following conclusions:

The section of the conduit as built was very well adapted for doing effective gunite work, the nozzleman always working to good advantage regardless of what part of the conduit he was working on. It is important in planning gunite work that the nozzleman be enabled to shoot at the surfaces as near as possible with the material nozzle in a position not less than 3 ft. away from the forms, pointing the nozzle at a right angle to the surface. When on account of obstructions, the nozzleman is compelled to shoot at a surface at an angle considerably less than 90 degrees, the result will be that the gunite will build up in ridges like a sandy river bottom and will not be dense and uniform. An excessive amount of rebound will also result from this cause. It is also desirable to have, if possible, only one layer of reinforcement in a gunite section. This will tend to keep the rebound down to a minimum. For reinforcement wire mesh is preferable to bars. If bars must be used then the bars should be round. Square bars have a tendency to produce a small triangular area of rebound material back of the bars which contains practically no cement at all.

A larger section of conduit could be built at considerably less cost per cubic yard of gunite in place because there would be less loss in time in moving equipment along the ditch and a smaller proportion of loss of material, and also less expense in finishing. The principal advantage in constructing the conduit section as designed was that all crews could work simultaneously without interfering with each other, and that there was no delay on account of removing inside forms which is one of the troublesome features attending the building of a continuous concrete pipe of small cross-sectional area. For obvious reasons this type of conduit would not be economical for heavy pressures, for which condition a circular section should be adopted.

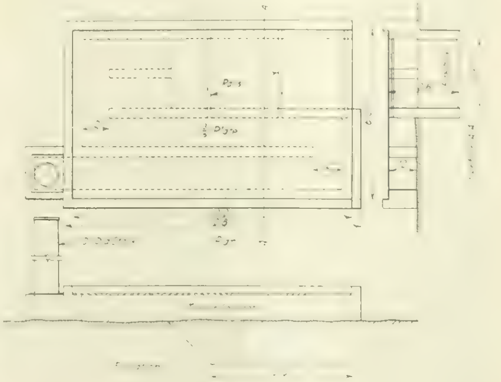
Fig. 7—Detail of Sand Drier.

The best results in guniting were always obtained when the material hose was 100 ft. or less in length; 250 ft. was the maximum length of hose used on the job. Air pressure should preferably be not less than 35 lb. per sq. in. at the gun, and water pressure should be greater than the air pressure by at least 10 lb. per sq. in. A mistake is often made in gunite work in using sand that is absolutely dry. The writer finds that the best results can be obtained when sand retains from 5 to 7 per cent moisture. The tendency to dust at the nozzle will then be eliminated and the material will not separate even in a long line of hose. The air, however, must be delivered dry to the gun.

For purposes of comparison with circular conduits the equivalent diameter of the 36-in. gunite conduit was assumed at 31 in., and the equivalent diameter of the 24-in. gunite conduit at 20 in.

The method of constructing gunite pipe as developed on this work is not patented, nor does the writer intend to take out a patent thereon. The work was designed and constructed by force account under the personal supervision of the writer, with O. A. Abelson as designing engineer and J. A. Kuehl and R. Bergerson as constructing engineers.

Kansas City Votes $11,000,000 Bond Issue for Waterworks. At an election April 4 citizens of Kansas City, Mo., authorized an $11,000,000 bond issue for the construction of new waterworks. The present water supply plant of Kansas City was built 36 years ago when the city had a population of less than 150,000. It has been enlarged from time to time.

Pump Performance and Costs of Large Drainage Pumping Plant

The Boundary Drainage Pumping Plant of the Yuma Project, of the U. S. Reclamation Service, is located practically on the boundary line between the United States and Mexico, about 26 miles south of Yuma, Ariz., and 1 mile east of the Colorado River. It is used for pumping drainage water from approximately 50,000 acres of land. In the February issue of the Reclamation Record, D. C. McConaughy, office engineer of the Yuma Project, gives the following information on the operation of this plant for the fiscal year 1921.

The pumping station building is a reinforced concrete structure built into the levee, with door and window sills 7½ feet above the operating floor, arranged so that in case of a break in the levee, with consequent flooding of the low lands, the plant can still be operated.

The present pumping equipment consists of one 36-in. Wood screw pump, with a normal capacity of about 60 second-feet, direct connected to a 100-H. P. Fairbanks-Morse & Co. type Y semi-Diesel oil engine, and one 30-in. Wood screw pump, normal capacity 30 second-feet, direct connected to a 75-H. P. oil engine. Auxiliary equipment is provided for starting the main units, consisting of one air compressor, one 2½-in. centrifugal pump, and two vacuum pumps, connected by belts to a line shaft driven by a 10-H. P. oil engine.

California crude oil, from 24 to 27 Baume, is used for fuel, and is stored in a 20,000-gal. horizontal cylindrical tank. Fuel consumption is determined from tables giving the computed capacity of the tank for each inch in depth.

Foundations and discharge pipes are already constructed for two additional pumping units, similar to the larger unit now installed, and conduits for wires are installed to permit connection of electric motors to all pumps whenever electric power is available.

Water flows by gravity through drain canals to the pumping station, and is there pumped through the levee and discharged into the Colorado River. The lift is variable, both on account of the variation in the elevation of river water surface at different seasons of the year and because the pumps are operated normally but a portion of each day, allowing the water to accumulate in the forebay.

The discharge measurements are based on the capacity of the pumps as determined by a test run. The lift at the beginning and at the end of the day's run is measured and the mean of the two measurements is taken as the average lift, with this figure given, the discharge is taken from the curve. Although this method does not give the true average head, since the storage capacity of the drain increases with the depth, it is found that the error is negligible so far as the discharge is concerned on account of the flatness of the pump capacity curve.

During the past year the plant was operated on an average of 8½ hours a day, with an average lift of 9.25 ft., except for about 6 weeks during flood stage of the Colorado River, when the head reached a maximum of 14.2 ft. and the maximum daily operation was 22 hours.

The force employed has consisted of a chief operator and one assistant operator, with a third during the period of high water. A small amount of common labor was used at times in clearing trash racks and similar work. No additions to the force will be required when the additional units are installed.

The total cost of the present plant was $130,750, and the estimated cost of the two additional motor-driven pumps, with transmission line, transformers, etc., is $56,600. The performance and operating costs for the fiscal year 1921 are given in the accompanying tables. Supplies are carried by rail direct to the plant and the cost of transportation at regular rates is included in the table of costs. The costs of operation are net and do not include overhead, interest, sinking fund or depreciation.

TOTAL COST FOR BOUNDARY PUMPING PLANT FOR FISCAL YEAR ENDING JUNE 30, 1921

	Total	Per acre-foot	Per foot acre-foot
Operation:			
Labor	[illegible]	0.164	
Fuel	[illegible]	.124	
[illegible]	[illegible]	[illegible]	
Repairs to Machinery:			
Labor	[illegible]	.017	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]		
[illegible]	[illegible]	.01[illegible]	
Total cost	[illegible]	$0.[illegible]7	$0.0[illegible]

PUMP PERFORMANCE, BOUNDARY PUMPING PLANT, FISCAL YEAR ENDING JUNE 30, 1921

	Av. hours run per day		Av. lift		Water pumped		Gals. fuel oil.	
	75 Hp	[illegible]	[illegible]	100 Hp	Acre-feet	Foot acre-feet	Per acre-foot.	Per foot acre-foot
July	10.6	8.[illegible]	[illegible]	10.1	2,130	21,130	1.38	0.13
August	10.3	8.9	[illegible]	9.7	2,200	21,040	1.63	.17
September	9.8	9.[illegible]	[illegible]	[illegible]	2,230	20,740	1.14	.12
October	7.5	8.1	[illegible]	[illegible]	1,860	17,480	1.10	.12
November	7.8	[illegible]	9.2	[illegible]	1,710	15,810	1.[illegible]	.11
December	7.5	[illegible]	[illegible]	[illegible]	1,740	16,180	1.18	.13
January	7.0	7.[illegible]	[illegible]	9.2	1,670	[illegible],400	1.[illegible]	.15
February	7.4	[illegible]	[illegible]	9.3	1,600	14,[illegible]40	1.31	.14
March	7.[illegible]	8.1	[illegible]	[illegible]	1,950	18,140	1.[illegible]3	.14
April	6.1	10.[illegible]	[illegible]	9.2	2,[illegible]90	21,830	1.09	.12
May	12.1	[illegible]	[illegible]	[illegible]	[illegible]	31,[illegible]	1.38	.1[illegible]
June	14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]9,310	1.71	.14
Total	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]3,170	1.34	.13

Operating Results of Experimental Activated Sludge Plant at Indianapolis

During 1921 the Board of Sanitary Commissioners of the Sanitary District of Indianapolis, Ind., of which Charles H. Hurd is consulting engineer, constructed a demonstration activated sludge plant and operated it in connection with a screen and sedimentation plant to determine the effectiveness of this method of treatment on Indianapolis sewage. The operating results of the plant are given in a recently issued report of the Board, from which the notes following are taken:

Three complete units were installed with aeration tanks 12 ft. in diameter and 15 ft. high and settling tanks about one-half the capacity of the aerators. Air was supplied through filtros tile in the usual manner, provision being made for filtering and scrubbing the air to eliminate dust or particles of oil which would tend to clog the filtros plates.

At this plant both screened and unscreened sewage is available. In the first run of ten weeks, two units were operated under identical conditions to show comparative results with and without screenings, and the third unit to demonstrate if possible any advantage of mechanical agitation. This run which was fairly typical of subsequent tests, gave the general results, shown in Table I, for aeration tanks No. 1 and No. 2. Tank No. 1 was operated on unscreened sewage pumped directly from the main interceptor and tank No. 2 on the effluent from the demonstration plant.

Table I shows general results obtained, but does not indicate the advantage of the uniformity of operation of No. 2 tank nor the difficulties which were experienced in the handling of undigested solids in tank No. 1. Tank No. 3, which was operated on a combined plan using both air and mechanical stirring, did not give satisfactory stability or effluent and was abandoned at the end of this run.

Encouraged by the results of a small baffled tank used as a circulating unit with filtros tile arranged to give rapid circulation by the air lifting effect, tanks Nos. 2 and 3 have been equipped in this manner and No. 1 is being operated in the standard form as a control unit. The filtros areas in No. 2 and 3 are 10 per cent and 12 per cent, respectively, and they are similar in construction except that No. 3 has an additional baffle. Tank No. 1 has 25 per cent filtros tile area. The three tanks are operated on screened sewage.

Delay was experienced in placing these new units in operation due to extremely high river during November and the first half of December. All three units are now "tuned up" and producing an effluent of high stability. Tanks No. 2 and No. 3 show a perceptible saving in the use of air over tank No. 1, operating with considerably less than one foot of air per gallon of sewage, and also having greater capacity with the same effluent standard.

TABLE I.—AVERAGE OPERATING RESULTS ACTIVATED SLUDGE PLANT

[illegible] Oct. 22, 1921.

	Tank No. 1 Unscreened sewage, p. p. m.	Tank No. 2. Screened sewage, p. p. m.
Suspended solids	25	19
Total solids	665	647
Oxygen consumed	30	26
Oxygen dissolved	[illegible]	3.1
Per cent saturation	[illegible]	36
Stability—days	[illegible]	7
Cubic feet of air per gallon	1.35	1.30
M. G. per acre per day	22	[illegible]1.5
Free ammonia	8.4	6.3
Albuminoid ammonia	[illegible].5	2.4
Activated sludge		
Pounds per million gallons	1,[illegible]56	1,152

Condition and Behavior of Core Material in Hydraulic Fill Dams*

By CHARLES H. PAUL.
Chief Engineer, Miami Conservancy District, Dayton, O.

Much has been written about the condition and behavior of core material in hydraulic-fill dams. A systematic study of the subject has been carried on during the construction of the five dams of the Miami Conservancy District, with the result that many of the doubts that have existed heretofore regarding the stability of hydraulic-fill cores, have been dispelled. It will be shown in this paper that:

1. The gradation of core material may be controlled during construction, even with borrow-pit materials of widely different character.
2. A considerable excess of fines is required in the borrow-pit material, in order to maintain proper control of the core and to prevent the encroachment of gravel and sand into the core zone.
3. A reasonably wide core, namely, core width at any point equal to height of dam above that point, may be obtained with absolute safety.
4. A fairly high percentage of extremely fine material in the core is not objectionable, provided the material is properly graded.
5. Such cores show a satisfactory rate of consolidation.
6. Such cores are stable, after a few months of consolidation, to the extent that they will not flow when the support of the outside slope material is removed.

General Features of the Miami Dams.—The five hydraulic-fill dams of the Miami Conservancy District form retarding basins to control flood discharges in the Miami Valley, Ohio. Table I gives the maximum height, length and volume of each of the Conservancy dams.

It will be noted that these dams vary in volume from 800,000 to 3,600,000 cu. yd. and in maximum height from 73 to 125 ft.

Fig. 1 shows the standard cross-section which was adopted for the Conservancy dams.

The construction of the dams was begun during the season of 1918, and all of them have now been completed. Two of them have already been in action during a flood flow in the river.

Borrow-Pit Studies Led to Hydraulic-Fill Construction.—Before the type of dams to be built in the Miami Valley was decided on, careful examination was made of foundation conditions and of materials available for construction. The foundation conditions dictated the selection of earth dams at all the sites, and borrow-pit investigations indicated that hydraulic-fill dams would be practicable and economical. The decision as to hydraulic-fill construction was not made, however, before consultation with several experts in that type of construction, and after careful mechanical analyses of the borrow-pit material to determine the relative quantities of coarse and fine, and especially the percentage and character of the material that would pass the 100-mesh sieve. These analyses, as well as precipitation tests, indicated that both in quantity and quality the fines in the borrow-pit material would meet the requirements of a good hydraulic-fill core. Further tests by the United States Bureau of Soils, at which better facilities are available than in the ordinary laboratory, including comparisons with similar material from other hydraulic-fill dams, confirmed the preliminary conclusions, namely, that the embankment material available was well suited to hydraulic-fill construction.

Design of Core.—Careful study was given to the design of the core for the Conservancy dams, with the result that the core width at any point was made equal to the height of the dam above that point. This gave a core of such shape that sloughing of the outside slope material would not be encouraged, and of sufficient width so that, with reasonable care, the encroaching of sand and gravel too far into the core zone could be prevented, and narrow enough so that additional material to that required to give stable slopes would not be necessary in order to hold the pressure of the semi-liquid part of the core during construction.

In order to obtain cores of the dimensions decided on, it became necessary, at one of the dams, to waste a considerable quantity of the core material available in the borrow-pit, and, at two others, to open auxiliary pits in clay deposits on adjacent hillsides, to make up for deficiency of fines in the main borrow-pits. There are decided advantages in having a surplus of core material available, so that a part at least of the finest of that material may be wasted: First, a better gradation of core material may thus be obtained; in fact, after the selection of the borrow-pits, and such selection of material in the pit as is practicable as excavation proceeds, the wasting of fines affords about the only remaining opportunity to control the gradation of the core material; and, second, a more rapid consolidation of core results, by disposing of some of the extremely fine particles which, otherwise, are held in suspension for a long period, tend to lubricate the whole mass, and retard the process of consolidation by the holding up of particles which of themselves would settle more rapidly.

The Goldbeck Pressure Cell.—In order to study the action of the hydraulic-fill cores during construction, it was determined to place at various elevations, in all the dams, a number of Goldbeck pressure cells. Preliminary experiments with these cells by the U. S. Bureau of Public Roads, at the writer's suggestion, indicated that they would give reasonably correct results if placed in hydraulic-fill cores. Briefly, the Goldbeck cell is a closed, flat, circular box, 5½ in. in diameter, similar in shape to a shoe-blacking box, the top or bottom of which acts as a movable diaphragm. It is operated by slowly admitting compressed air through a small pipe, to the inside of the box. The air is supplied from a small tank which may be charged with an ordinary tire pump. The cell is buried at a known elevation in the core, and the movable diaphragm is held down by the pressure of the material. When the pressure of the air on the inside equals the pressure of the material on the outside, the diaphragm is lifted slightly, an electric contact is broken, and an indicator light in the registering apparatus goes out. At that instant, the gauge on the air line indicates the pressure of the material against the movable diaphragm. The operation of the cell requires a movement of the diaphragm of less than 0.001 in. The cell may be set either horizontally or vertically, and, thus, either vertical or lateral pressure may be determined.

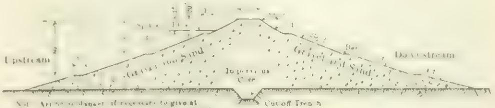

Fig. 1—Standard Cross Section of Conservancy Dams.

In addition to the Goldbeck cells, it was planned also to use the ordinary rod and ball tests, as construction proceeded.

Construction Methods.—The embankment material was pumped into each of the conservancy dams, by 15-in. dredge pumps, as it was impossible to sluice directly from the borrow-pit to the embankment. In two cases, however, the borrow-pit material was broken up by hydraulic giants and sluiced to sumps where it was picked up by the dredge pumps and pumped into place. At the other three dams, the borrow-pit material was excavated by drag-line machines, loaded into cars, hauled to the dams, and dumped into long shallow bins or hog boxes. At the hog boxes, hydraulic giants were used to wash the material to the dredge pumps. Thus, it will be seen that, by the time it reached its place in the dam, the borrow-pit material was thoroughly broken up and separated.

The discharge pipes laid down this material along the outer edge on either side of the dam section; a low levee or dike, along the outside slope, forced the discharge to flow toward the center where the core pool was maintained. The usual separation, characteristic of hydraulic fill construction, was thus obtained. The coarser material, consisting of cobbles, gravel and coarse sand, remained in the outer parts of the embankment, and the fine sand, clay and silt flowed to the center with the water, and settled through the core pool, to form the impervious core.

TABLE I—SIZE OF MIAMI CONSERVANCY HYDRAULIC-FILL DAMS

	Germantown Dam.	Englewood. Dam	Lockington Dam	Taylorsville. Dam.	Huffman. Dam.
Max. height, in ft....	110	125	78	78	73
Length, in feet... ...	1,200	4,700	6,400	3,000	3,300
Volume, in cu. yds....	800,000	3,600,000	970,000	1,130,000	1,350,000

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*Abstract of a paper entitled "Core Studies in the Hydraulic Fill Dams of the Miami Conservancy District," on pp. 452-472 of Vol. XLVIII, No. 3 (March), Proceedings of the American Society of Civil Engineers.

Distribution of Material in Dam Section.—In every case, this general separation of material was obtained to the extent that the outside slope material was pervious, free draining, and composed largely of coarse particles, whereas, the cores were impervious and of fine material. It should be noted, however, that the theoretical gradation of material outside the core zone, from coarse at the outside to fine toward the center, is hardly perceptible, except by careful examination, and then only in a general way. Although the material near the outside slope line contains a larger percentage of coarse particles and is more pervious than that near the edge of the core, still considerable coarse gravel is distributed through the section of the dam from the outside slope to the edge of the core, and there is considerable sand near the outside slope as well as near the core zone, which is of no detriment. It is also true, however, that a considerable quantity of the fines is trapped in this outside slope material, which is of importance and must be taken into consideration in any analyses of borrow-pit material. Unless such analysis shows a large surplus of fines in addition to that required by the theoretical core section, it is almost certain that the necessity of an additional supply of core material will develop during construction. This happened at two of the conservancy dams, and although it was not entirely unexpected at one of them, it had not been anticipated at the other.

At all five of the dams there was a distinct deposition of sand at the edge of the core pool, forming a definite separation between the slope material and the core material. The water flowing down the beaches from the discharge end of the dredge pipe, dropping the gravel and coarser material along the way, carried still an appreciable quantity of coarse sand when it reached the core pool. Its velocity was checked as it entered the pool and its burden of coarse sand was immediately dropped, only the finest of the material, that is, the fine sand, clay and silt, going into the core zone where it settled slowly through the core pool. This, in general, was what happened when construction conditions were right. Irregularity in shore line, concentration of flow down the beach, deficiency of core material, and similar unfavorable conditions which continually occur on construction work, regardless of how well it is organized, occasionally resulted in tongues of the coarser material extending into the core zone, thus emphasizing the necessity of a reasonably wide core section to take care of such contingencies which, however undesirable, can hardly be eliminated.

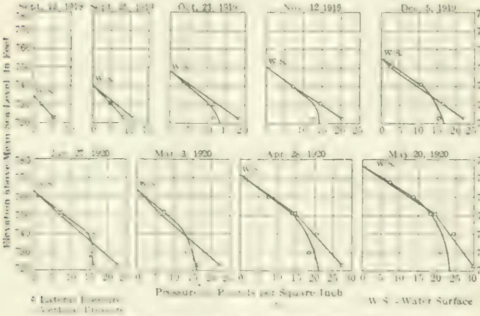


Fig. 2—Readings at Germantown Dam.

Core Tests.—The limitation of fines in the core material of the conservancy dams was largely a matter of judgment, based on the analysis of core materials available, preliminary tests made in co-operation with the U. S. Bureau of Public Roads, and analyses of cores secured from other hydraulic-fill dams. After construction was started, frequent analyses of the core materials were obtained through the co-operation of the U. S. Bureau of Soils, and the rates of consolidation were studied. Table II shows the results of some of the analyses of typical core material.

Although cores of quite different compositions from those given may show as good results, it may be said that all five of these dams have been completed without the least indication of trouble with any of the cores, with ample proof that consolidation has taken place in a thoroughly satisfactory manner, and that the watertightness of the cores, as shown by several tests, is all that could be desired. In the writer's opinion, the most striking fact revealed by a study of Table II, is that, with proper care, cores remarkably similar in composition can be obtained from different borrow-pit materials, in different river valleys, at points from 10 to 50 miles apart. It is not claimed that the gradation shown by these analyses cannot be improved, but the results obtained at the conservancy dams indicate conclusively that cores of about the composition shown are eminently satisfactory from the standpoints of rate of consolidation, degree of con-

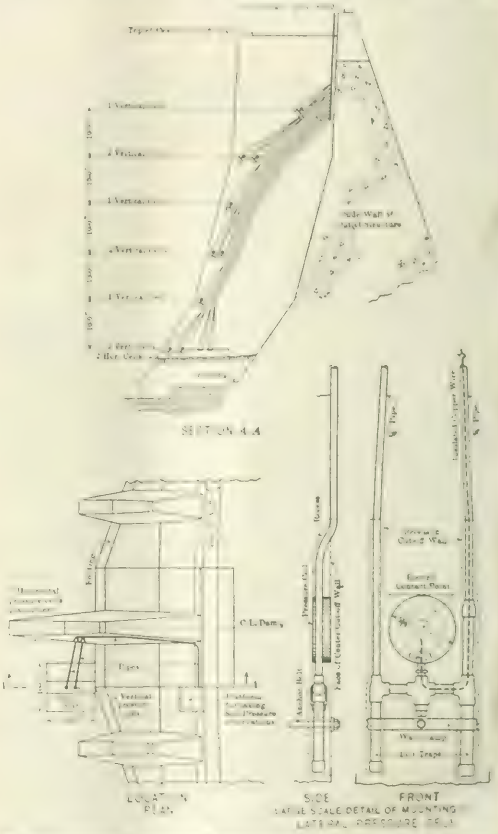


Fig. 3—Improved Installation of Pressure Cell at Taylorsville Dam

TABLE II.—MECHANICAL ANALYSES OF TYPICAL CORE SAMPLES

[illegible]	[illegible]			[illegible]					Lockington				Taylorsville						Huffman				Average
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.5	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	15.6	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	52.5	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

solidation, and water-tightness. To call to mind, again, the different conditions under which these cores were obtained, it may be stated that at Lockington and Englewood the borrow-pit material was used as it came, with only such control as could be secured by varying the depth of excavation, thus obtaining a greater or less proportion of the clay overburden, or by such other selection of materials as could reasonably be made without unduly increasing the cost of excavation. At Germantown and Huffman, the main borrow pits were deficient in fines, and auxiliary borrow-pits, yielding a high percentage of clay, had to be opened. At Taylorsville, there was a large surplus of fines in the borrow pit, and a considerable percentage of the core material had to be wasted. In the latter case, there was the ever-present temptation to decrease the cost by holding a large percentage of fines, and taking chances on a wider core than that called for by the design. In the other case, one had to reckon with the desire to narrow the core to fit the borrow-pit conditions. Perhaps both these modifications might have been made, within reasonable limits, without detriment to the work. In the light of present knowledge, however, it is believed that either would have been undesirable, and might have led to trouble.

Pressure Cell Tests.—About fifty of the Goldbeck pressure cells were placed in the cores of these five dams. Some have given satisfactory readings, and some have not. In cases where the readings look unreasonable, or where the cells fail to register, it is sometimes difficult to determine whether the trouble is in the cell or is due to faulty installation. With a few exceptions, there is no evidence that any of the unsatisfactory results have been due to fault in the cell itself. Defective installation is known to have been the cause of many of the unsatisfactory readings, and improvements in installation have resulted in marked improvements in results. This was a pioneer effort, and, naturally, much was to be learned by experience, before proper methods were determined for meeting the requirements, particularly as to the best methods of installation. The first installation was made at the Germantown Dam. At this dam, the cells were suspended, by two ¼-in. pipes, from the top of a framed tower which was built in sections as the construction proceeded. Two pipes were necessary at these installations, one to carry the wire connecting with the registering apparatus and to take the charge of compressed air, and the other to be used as a blow-off in case water entered the pipe or the cell. This method of installation, however, was improved later. (See Fig. 3.)

Cells were set in a vertical position (to measure lateral pressures) at 10-ft. vertical intervals, and in horizontal position (to measure vertical pressures) at 30-ft. vertical intervals. As the tower was raised in height, the pipes were extended by connecting another section at the top, and another length of wire (bell cord) was spliced on and threaded through the one pipe. The tower, surrounded by the soft core, was guyed at intervals to hold it in place.

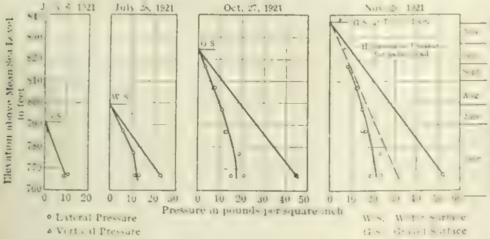


Fig. 4—Results of Readings at Taylorsville Dam.

In taking the readings, a portable gauge box was taken out to the tower, and connected to one of the pipes from which the cell to be tested was suspended, the pipe being connected to the pressure tank and the wire to the indicator light. A plug was removed from the end of the other pipe and a light "shot" of compressed air was admitted to the first pipe to displace any water which might have accumulated. It was only necessary to force this water out of the way so as to admit air to the cell, since the weight of a water column (if any) in the second pipe would register on the pressure gauge, and, therefore, would not affect the correctness of the reading; as a matter of fact, little trouble with water was encountered. The plug was then replaced in the end of the second pipe, and the compressed air was admitted slowly to the cell, until the movement of the diaphragm broke contact and put out the light in the gauge box. At that instant, the pressure gauge indicated the core pressure on the diaphragm. The movement of the diaphragm necessary to break contact (about 0.0001 in.) is so slight that the light may be put out and lighted repeatedly, by proper manipulation of the feed and exhaust valves, without changing the reading of the pressure gauge, thus showing that the slight movement of the diaphragm does not disturb the core.

A series of readings at Germantown, covering the period from Sept. 10th, 1919, to May 20th, 1920, are shown on Fig. 2.

These tests show that after a few weeks the core material begins to consolidate (as indicated by the fact that the lateral pressures are noticeably less than the vertical pressures at the same elevations) and that as time goes on the difference becomes greater, until after a few months the lateral pressures in the lower parts of the core are only about two-thirds to one-half the vertical pressures. In the writer's opinion this is conclusive evidence that the core at those points is losing its fluid properties and that consolidation is taking place. These conclusions are confirmed by later examinations of exposed cores, as will be mentioned.

Fig. 5—Exposed Core of Huffman Dam.

These nine series of readings at Germantown, covering a period of eight months, were very satisfactory. Then things began to happen. The dam had reached a height of from 60 to 70 ft. and was being constructed at the rate of about 6 or 8 ft. per month. It became impossible to obtain further readings on some of the lower cells because air could no longer be forced through the pipe to the cell. This plugging of the pipe was due, in some cases, to the bunching of the insulation on the wire or at the splices, and, in others, to an accumulated deposit of dirt and flakes of galvanizing. When the length of this small pipe is considered (70 to 80 ft. in the case of the lower cells), this latter trouble is not surprising, although it was overlooked at the start. The use of larger pipe, more careful cleaning of the inside of the pipe, and the construction of a trap at the bottom of the pipe to catch the dirt, corrected these troubles in later installations. Some of the pipe joints then began to leak air, and, about that time, the upper part of the tower showed signs of distress, due probably to movement in the upper (partly fluid) portion of the core or to the settlement of material on the guys. This movement of the partly consolidated portion of the core was demonstrated by sinking a cast-iron ball into it, marking its position by a buoy, and checking that position from time to time. This simple test gave positive evidence that, in the earlier stages of consolidation, there is often some movement, or surging, of the semi-fluid core. Such movement, in itself, is of little consequence, except that it must be given consideration in cases where it is desired to construct a permanent tower or shaft within the limits of the core. Difficulties with such towers or shafts have been experienced in other hydraulic-fill dams, due no doubt to this core movement.

Thus, the pressure-cell tests at Germantown, following the period covered by the readings shown in Fig. 2, were of interest, principally in revealing defects to be corrected in future installations. The Englewood and Lockington installations were too far along to be corrected by the time the Germantown troubles had been analyzed. The readings obtained at these places confirmed the conclusions reached from the Germantown tests, but little additional information was secured, beyond what is shown in Fig. 2.

At Taylorsville, full advantage was taken of the experience gained at the other dams and a much better installation was made. In this case the cells were fastened to the side of a concrete cut-off on the back of a high retaining wall forming a part of the outlet structure. Larger pipes were used, which were fastened securely to the same wall and instead of joining up the pipe in sections as the dam was raised, the complete installation was made at the start. At the pipe joints special care was taken to secure a permanently air-tight joint. Dirt traps were provided at the bottom of all the pipes (Fig. 3).

Cells in vertical position to measure lateral pressures, were set at 10-ft. vertical intervals as before, but in this case two cells were set at the bottom and at the 20-ft. intervals, in order to check the readings of one against the other, at those points. Cells to measure the vertical pressures were set at the bottom only, because of the difficulties of making a secure installation in horizontal position at the higher elevations, except at points where the vertical pressure would be affected by friction against the wall. Fig. 4 gives the results of readings at Taylorsville.

It will be noted that the two cells at the 20-ft. vertical intervals check each other very closely, except at the bottom, where consolidation has taken place to the extent that the lateral pressures are only about 40 per cent of the vertical pressures. This is an indication that the pressure-cell readings are fairly reliable. It might be expected that when consolidation has reached the point where the core is practically a solid, actual lateral pressure might vary at different points to the extent indicated by the readings on the lower cells. The last set of readings (Nov. 26th) were taken after the completion of the dam to its full height. The section of the dam in which the cells were set, was built up from Elevation 767, where the lowest cells are located, to Elevation 837, the top of the dam, during a period of six months; during one month the core was raised 33 ft. The monthly progress of construction of that section is shown on Fig. 4.

The Taylorsville method of installation is apparently satisfactory. The results to date have every indication of being reliable; they check with the readings at Germantown, as shown in Fig. 2, and they appear reasonable in the light of examinations of the cores in place, discussion of which will follow. The readings at Taylorsville will be continued for several months, or as long as any further information can be secured from them.

It is evident, from the data secured thus far, that properly graded core material need not be treated as a perfect fluid even after a few weeks of settlement, and that after it has been in place for a few months, the lateral pressure is only about 50 per cent or less, of the vertical pressure at the same depth. It is believed that this may be accepted as a fact, to be kept in mind in the future design of hydraulic-fill dams.

Ball and Rod Tests.—Penetration tests with a 6-in. cast-iron ball, and with iron rods, were made at all the dams as the work progressed. These tests have been already described, and as they are not of great importance, the discussion will not be repeated here. They indicated satisfactory and progressive consolidation of the core in all cases. Rod tests are of value in detecting the presence of gravel in the core.

Actual Core Examinations. By far the most satisfactory and conclusive information as to the character of the cores of the Conservancy dams, has been obtained at three of the dams, by examination of the cores where they have been exposed in their undisturbed condition. At the Huffman Dam, the old line of the Erie Railroad passed through the dam site. The construction of the dam was started while the railroad was being relocated and in order not to delay this construction, a cross-dam was built along the edge of the railroad right of way, which held back the hydraulic core until after the tracks were moved. The core pool was then drained, the preparation of the foundation was made across the railroad right of way, and the cross-dam through the core section was removed, exposing the end of the core to a depth of 26 ft. Fig. 5 shows the core thus exposed.

Although 16 ft. of water stood against the exposed face of the core and although it stood unsupported to a height of about 10 ft. above the water surface, little difficulty was experienced in clearing the foundation for the new section of the core and excavating the continuation of the cut-off trench. The texture of the core in the steep face and how the bucket load of core, dumped by the drag-line machine, retains its shape may be noted in Fig. 5. The oldest of the core visible in this photograph had been in place about five months, and the top of it had been placed about two weeks before the photograph was taken. It would bear the weight of a man walking across it, after the core pool had been drained. The composition of this core material is represented by the Huffman analysis in Table II. When studying this photograph, it should be kept in mind that the face of the core, below the water surface, was undercut by the excavation for the removal of the cross-dam and the continuation of the cut-off trench, which explains the slumping near the face.

At the Lockington Dam, when construction had been carried to within about 12 ft. of the top, the core pool overflowed, washing a gully in the up-stream slope of the dam and exposing the core to a depth of about 20 ft. from the top. A similar accident occurred at Englewood, at about the same stage of completion. In each case, all the water in the core pool drained through the break. At Englewood, the quantity of water drained was estimated at not less than 800,000 gal. In both cases the core stood up with almost vertical faces and none of it washed out, except just at the break. Only about 10 per cent of the material moved by the wash-out was core material.

Samples of the core material from these places were taken in both cases. At Lockington, five samples were taken at different places, after digging into the exposed face far enough to reach material that had not been disturbed or affected by the wash-out. Each of the samples was secured by using a 7-in. length of stove pipe, biscuit-cutter fashion, and immediately soldering on a top and a bottom, thus forming an hermetically sealed can, full of core as it lay in the dam. The moisture content of these five samples, as determined by the Bureau of Soils, varied from 21.8 to 22.6 per cent by weight. The mechanical analysis averaged, as follows:

1-0.5 mm.	0.5-0.25 mm.	0.25-0.10 mm.	0.10-0.05 mm.	0.05-0.005 mm.	0.005-0 mm.
0	2%	6%	15%	55%	21%

which agrees well with the typical analysis of the Lockington core samples, given in Table II. The low moisture content shows that the core gives up its surplus water within a comparatively short time; there is no doubt of that after an examination of the exposed core in place. Similar samples taken at Englewood had a moisture content of about 24 per cent. The weight per cubic foot was about 121 lb. A large number of pieces of core material at Englewood, some of which were 1 cu. yd. or more in size, were found at the foot of the slope after the wash-out, which showed the toughness of the core material. The Englewood wash-out occurred in a section of the dam that had been built up as much as 30 ft. vertically in 1 month, so it is evident that consolidation takes place rapidly, even when construction progress is fast. In the face of the evidence offered by these core exposures, there is no doubt that consolidation of these cores has progressed at a highly satisfactory rate.

How the Core Gives Up Its Surplus Water.—There is difference of opinion as to how the surplus water escapes from the core. Experience at the Conservancy dams indicates that this process is more rapid than could occur by ordinary filtration action. It is very likely that some of the water drains out laterally, but there are indications that the greater quantity is displaced and forced up vertically, by settlement of the solids and by pressure due to the superimposed material. In many places, where pumping had been discontinued temporarily, innumerable little springs might be seen in the bottom of the core pool, where water was being forced up by piping.

There is further evidence that comparatively little of the water in the core material escapes laterally. While the dams were being built, seepage water was always in evidence at the toe of the porous slopes. This flow was greatly diminished at times when the dredge pumps were shut down and the level of the core pool had dropped 1 or 2 ft. During the construction of hydraulic-fill dams in the arid West, vegetation will grow at the foot of the slopes while hydraulic fill is in progress, but as soon as the work is discontinued, the vegetation will die for lack of water, the explanation being that along the edge of the core pool, immediately below the surface, is a strip of porous slope material not yet silted up by the core; as soon as the water surface drops below this unsilted material, little water escapes through the slopes, and the core pool holds the remainder of the water for a long time. The little springs are still in action, however, and the consolidation of the core goes on, forcing the surplus water to the surface. It is difficult to explain the rapid consolidation of the Conservancy cores in any other way.

Gravel and Sand Sloughing Into Core. Once at Huffman and several times at Englewood, trouble was experienced by the gravel and sand sloughing or raveling into the core, its presence being detected by the rod soundings. In every case, this happened when the core material was not brought up fast enough to correspond with the building up of the outside slope material, and it could always be prevented by keeping the core well filled with mud. The coarser material takes a fairly steep slope next the core pool, and each layer overhangs the one below. Water pressure is not sufficient to hold it in place. If the core pool is kept well filled with mud, however, it consolidates fast enough to keep the coarse material from sloughing in, and, here again, the advantage is apparent of having a surplus of fines in the core material so that some of the finest may be wasted.

A concentrated flow down the beach from the dredge pipe will tend to carry a tongue of gravel and sand out into the core. This may be prevented by shear boards to break up the concentration of flow, or by a floating timber held in by ropes close to the shore of the core pool, at the point where the flow enters the pool. By building up the dam in lifts of not more than 2 or 3 ft. at a time, this trouble may be avoided more easily.

Progress of Construction.—It may be of interest to give a general idea of the rate of progress on the Conservancy dams. At Germantown, with one drag-line machine in the borrow-pit, and one dredge pump, an average month's work was about 60,000 to 70,000 cu. yd., and during one month, the output reached 91,500 cu. yd. At Huffman, with similar equipment, the rate of progress was about the same, although at Lockington, the progress was somewhat less. At Taylorsville, with four giants in the borrow-pits and two dredge pumps, the highest monthly estimate was 107,000 cu. yd. At Englewood, with three drag-line machines in the borrow-pit, and two dredge pumps, the quantity of material placed in the dam often reached 150,000 cu. yd. per month, and during one month it was 180,000 cu. yd.

Typhoid Fever in New York During 1921.—According to the Weekly Bulletin of the Department of Health of New York City for Feb. 4 there were 899 verified cases of typhoid fever in New York City in 1921 compared with 969 verified cases for 1920; a total of 124 deaths were reported during 1921 as against 137 for 1920. Forty per cent of the cases were traced to probable sources of infection as against 35.6 per cent in 1920. During 1921, 97 cases were traced to contact infection, of which number 47 were due to contact with active cases, 13 cases were due to proven carriers, and 37 cases were due to suspected carriers. Two hundred and fifty-four cases were traced to sources out of town, 3 cases were traced to flies, 5 cases to shellfish and no cases were traced to contaminated milk. Sixty-six per cent of the cases were confirmed by laboratory test against 77.2 per cent in 1920. During both years, 63 per cent of the cases were hospitalized. In 1921, 1,798 persons were immunized against typhoid by the Department of Health. With the exception of 1919, when there were 854 cases and 121 deaths from typhoid fever, last year is the lowest one on record. The death rate per 100,000 continues to be 2, while the case rate per 100,000 is 15.8. The fatality for 1921 is 13.8 per cent, while in 1920 it was 14.1 per cent. Twenty-eight cases of para-typhoid fever were reported during the year.

Portland Cement Production in 1921.—Preliminary estimates by the U. S. Geological Survey show that the production of portland cement in 1921—98,293,000 bbl.—was more than 98 per cent as great as that in 1920, the "record" year. The total shipments in 1921, about 95,051,000 bbl., were nearly 99 per cent to those in 1920. The stock of finished cement at the mills at the end of 1921, about 11,938,000 bbl., showed an increase over the stock at the end of 1920 of more than 33 per cent. This stock exceeded the average stock in hand at the end of each of the years 1917 to 1921 by over 27 per cent. The average factory price in bulk at the mills for the whole country was $1.87 a barrel in 1921, as compared with $2.02 a barrel in 1920, a decrease of 7.4 per cent.

Cleaning Irrigation Canals with Modified Disk Harrows

One of the most perplexing problems of irrigation canal maintenance is the combating the growth of aquatic plants. This plant growth ordinarily does not affect the flow of water in a canal to a serious extent for two or three years after its construction. This is because the plant growth is brought into the canals with the water diverted from rivers and storage reservoirs, and some time is required for it to gain a sufficient foothold to obstruct the flow of water. Experiences in removing these growths from canals of the Minidoka Project of the U. S. Reclamation Service with modified disk harrows are related by Hugh L. Crawford, Assistant Engineer U. S. Reclamation Service in the February Reclamation Record. Appended to Mr. Crawford's report are some interesting comments on this maintenance method by Barry Dibble, Project Manager. We quote as follows from the above mentioned publication:

Kinds of Plant Growth in Minidoka Canal.—On the Minidoka Project the plant growth is of two kinds. Both of these are locally called "moss," and the operation of removing them from the canal is called "mossing." One kind is a sort of moss which covers the wetted perimeter of the canals like a blanket, particularly in sections where the velocity of flow is low. The other kind is not a moss but a long, slender plant, sometimes called seaweed, which grows from a small onion-shaped bulb. It sometimes attains a length of 6 ft. or more.

The growth of these plants is most rapid in warm weather, and about the last of June or the first of July the seaweed attains a length sufficient to bring it to the surface of the portions of the canals affected. The blanket moss entangles with it and the result is that the capacity of the canals is rapidly reduced. The rate of growth is so rapid as to frequently raise the water surface elevation 0.1 ft. in a 24-hour period for the same discharge. Unless this condition is remedied immediately the capacity of a given canal may be reduced as much as one-half and the water be forced over the banks. This damages the canal banks and may lead to serious breaks, as well as injury to crops, by flooding at some points and by lack of water at others.

Method of Removing the "Moss."—Various methods of removal were tried out on this project with indifferent success. The canal bottoms were dragged with spike-tooth harrows, spring-tooth harrows, and heavy log chains. The Ziemisen submarine saw was used in the canals. In the smaller laterals men with scythes waded and mowed the seaweed. An ordinary farm disk harrow was tried and found ineffective.

Of all the methods tried the submarine saw and the scythes were the most effective agents. They were, however, very slow and expensive. It was necessary to cover the same ground every two or three weeks. The use of scythes also worked a considerable hardship on the laborers, who were forced to spend long hours in the water. Log chains could be used only late in the season, when the moss was ripe.

Watermaster George Haycock learned that the South Side Twin Falls Project had been using a disk harrow with a specially constructed tongue or draw bar with good results. Inspection of this machine at Twin Falls indicated that it would assist in solving the moss problem for the Minidoka Project, and arrangements were made for the purchase of one complete disking outfit from the Twin Falls Canal Co. On its delivery it was put in operation on the lower end of the J or third lift canal.

The results were even better than had been expected. The machine not only removed moss, but also went down into the silt on the canal bottom and loosened a great part of the moss bulbs which then floated out of the canal. This was removing the root of the trouble, and it was found that only two cleanings were necessary for the season instead of one every two or three weeks with saws and scythes.

Progress and Cost of Cleaning with Harrow.—On cleaning moss a crew averaged 1 mile per day of main canal and 1¾ miles of lateral. The main canals varied from 20 to 25 ft. wide on the water line and the laterals 8 to 10 ft. A crew for moss work consisted of a foreman, two teamsters and teams, who worked with the disk, and one laborer, who was stationed on the first check below to remove floating moss. It is believed that with a little closer co-operation with the farmers this last man will not be needed.

The cost per day of the above crew was $18.50 exclusive of [illegible]. The average cost per mile with the disk for canals and laterals was $15 to $17. Cutting moss by hand cost [illegible] per mile in 1920 and [illegible] in 1921 for one cutting.

In working with the disks it was observed that the water below the point where the machines operated was heavily laden with silt. This suggested that much cleaning of the [illegible] might be done with these disks late in the season, when it would be possible to remove all checks and to waste water from the canals to the river in considerable quantity. Two disks were operated on this work with an interval of approximately ¼ mile between them. They covered on the average 1½ miles per day. Seventy and three-tenths miles of canal were covered in this work and the results were even better than had been expected. After the water was turned out of the canals a careful inspection was made, and it was found that those portions of canal where the disks had been used were in good shape for the 1922 water season without any more work. It was roughly estimated that it would have been necessary to remove about [illegible] cu. yd. of silt from the portion of the canals covered by the disks if they had not been used. On this basis the cost of removal was 3¼ ct. per cubic yard.

The chief drawback to the use of the disk is that it fills the weir and orifice pools with silt. These pools have to be cleaned at times in any case so the silting is not serious as compared with the saving in cost of silt removal.

The Modified Disk Harrow.—The essential difference between the modified disk and the ordinary farm disk barrow is in the steel frame which connects the disks to the drawbar. It consists of two ⅝ by 1¾ in. steel bars bent to form a semicircle 3 ft. in diameter and placed one above the other at a distance of about 4 in. and rigidly bolted together at six points. A horizontal cross brace, consisting of a 1¾ by [illegible] by ¼ in. angle, joins the ends of the curved bars. A heavy tongue or draw bar about 8 ft. long and shod with steel on both sides is fastened at one end to the center of the angle-iron cross brace. This tongue works between the curved bars described above and can be swung to several angles and bolted rigidly to the semicircular part of the frame. A heavy steel ring is fastened to the other end of the tongue. To this ring two ⅜-in. crucible-steel cables 25 ft. in length are attached for lateral work, or two 50-ft. cables are used on the main canals. The disk is operated by a team on each bank hitched to one of these cables. By adjusting the angle of the tongue the disks may be made to travel on either side of the canal as desired.

Twenty-inch disks are used on ⅞-in steel shafts, and they are so attached to the frame that the cutting angle of the disks may be varied as desired. By the use of different length shafts disks may be added or taken off to vary the width of the machine according to the size of the canal. The weight of the complete machine with set of 10 disks is 415 lbs.

The average cost of two machines, complete, except for cables was $112.50 on the work at Burley.

Comments by Project Manager Barry Dibble.—We are at present expecting to try a smaller machine with two disks on each side for use in our smaller laterals, where we think the outfit will do excellent work.

The Minidoka Irrigation District has been using one of these disks during the past season. They have proposed two modifications which seem to have merit. One of them is a fender which they are making out of automobile springs and which will extend just beyond the outside disks. The machine as it has been built sometimes catches on obstructions in the canal bank, such as turnouts. It is thought that with this fender delay on this account will be avoided. Where the disk is working on a canal bank that is very steep, it can be made to climb the bank in order to clean off the moss that grows in the canal. When the disk is used for this purpose most of the weight is thrown onto the lower disks. The irrigation district has had trouble with the breaking of the outer disk on this account. They are now proposing to put a 16-in. disk inside and against the 20-in. disk so as to [illegible] and avoid this difficulty.

When the disk is used on steep banks it sometimes rolls entirely over. In order to avoid the twisting of the cable upon which it is pulled a swivel is required in the chain by which the cable is connected to the [illegible].

Mr. J. C. Wheelon, manager of the Twin Falls Canal Co., who designed the disk, states that on their project they have had to exercise some care to see that the laterals are not cut down too deep. In one or two cases the disking has been continued to a point where it was impossible to get water into the farm turnouts without putting in temporary checks. The disking of the canal seems to loosen the bulbs from which the "moss" grows and they are removed from the canal when the moss is thrown out. In this way—after a year or two—the moss is practically eradicated and further disking for this purpose is not necessary until the moss re-establishes itself.

In the discussion at the Idaho irrigation congress one of the canal company managers stated that he had met with considerable success in working the canal early before the moss had reached a length in excess of 18 in. In this way the moss and the attached bulbs were removed before they became a serious obstruction. It strikes me that this method of handling the moss has a distinct advantage, because when it is small it will neither clog the disk nor require any labor to throw it out of the canals, as it can be allowed to pass through the farm turnouts or wasteways.

The disk, however, is as useful for removing silt as it is for removing moss, and we expect to obtain important results in 1922.

A. A. E. Emphasizes Service Policy

Definite policies for improving the service to isolated members of the American Association of Engineers were an important development at the quarterly meeting of the board of directors of A. A. E. on March 24 and 25. This establishment of policies is the outcome of several months of discussion on the part of the chapters and the national officers.

The outstanding feature of the new recommended service policy is the proposed employment of several field secretaries, whose duties shall be to develop the employment service, organize new units and serve old units, and to facilitate cooperation between the various chapters, clubs and assemblies.

Chief among service features of A. A. E. is the employment service which, although it established an enviable record of accomplishment in 1921 when notice of 5,164 positions open were sent to members and 2,751 members placed in positions, has only begun to grow. The new plan of the board calls for greatly extending the employment service to make it more comprehensive and organizing it so that the benefits accruing may be more available for members residing at considerable distance from Chicago. It is proposed through the field secretaries and the national organization to make a determined effort to render special service to large groups, such as railroad, federal, practicing, and engineers in public service. The funds for this special service to groups are to be derived from fees and dues received from the entire membership.

To the end that this improved service may be accomplished at as early a date as possible, the National Executive Committee was directed to submit a budget for the coming year contemplating such extended and improved service and that the National Board of Directors submit such a plan to the annual convention.

Proposed amendments were endorsed favoring the establishment of several departments to serve groups of engineers which represent any considerable percentage of the membership, provided such departments are placed under the supervision of the National Board of Directors.

An exhaustive study of the plan for the formation of practically autonomous districts with paid staffs under the authority of National Headquarters, will be made in the next few months with a view to the further development of quicker and better service to the membership.

Hydro-Electric Progress in Canada in 1921.—During 1921 practically 300,000 HP. was added to the installed water-power plants in Canada according to a recent report of the Dominion Water Power Branch of the Canadian Department of the Interior. The same report contains the following comparison of water power development in Canada and the United States:

	[illegible]	[illegible]	[illegible]
Canada	[illegible]	[illegible]	[illegible]
United States	[illegible]	[illegible]	[illegible]

The total increase in horsepower installed in Canada from 1900 to 1920 was 15[illegible] per cent.

Annual Convention of A. A. E. in June.—The 8th annual convention of the American Association of Engineers will be held at Salt Lake City, Utah, on June 5, 6 and 7, 1922.

Action of Alkali Salt on Portland Cement Mortars

Experiments at Minnesota Laboratory Summarized in Paper Presented Feb. 23 Before Minnesota Surveyors' and Engineers' Society

By DALTON G. MILLER.
Senior Drainage Engineer, in Charge Cooperative Drain Tile Laboratory, University Farm, St. Paul.

The drain tile laboratory at University Farm, St. Paul, Minn., operates under a co-operative agreement of the Department of Agriculture, University of Minnesota, Department of Drainage and Waters, State of Minnesota, and the United States Department of Agriculture. Part of the funds which support this work were provided by a special act of the State Legislature during the 1920-1921 session while about an equal amount is provided by the United States Department of Agriculture.

The work at the laboratory can properly be divided into service work and research work. The service work consists of making physical tests of drain tile submitted by farmers, engineers and tile manufacturers, the testing of aggregates used in the manufacture of concrete tile and of analyzing waters submitted by engineers. The research work consists in the broadest sense of studies relating to the general improvement of the quality of drain tile and, at this time, especially of means looking towards the manufacture of a concrete tile that will endure under all soil conditions.

It is not at this time the intention to go into the details of the various phases of research work now under way in the laboratory. However, it is believed that an outline of the results to date of one set of experiments will be of considerable interest. These experiments consisted of making up 2 in. x 4 in. cement mortar cylinders and subjecting them to the action of solutions of magnesium sulphate, which is one of the two so-called alkalies commonly found in the southwestern part of the state. Two different types of cylinders were made in one of which Standard Ottawa sand was used and in the other a Minnesota sand from the west central part of the state. The Minnesota sand used was screened through a 20-mesh and retained on a 30-mesh so as to conform in this respect to Standard Ottawa. The sand was washed so as to give a colormetric test of 2 or better on the Abrams Harder Scale. Before screening and washing the test for silt and clay showed 0.76 per cent while the material retained on a ⅛-in. screen after passing a ⅜-in. contained 8.97 per cent of shale by volume.

Essential Features of Test Cylinders.—Briefly summarized the essential details of these cylinders were as follows: The cement used was a mixture of two brands in common use in the state. After mixing the cement was subjected to the A. S. T. M. standard tests and met all requirements. Distilled water was used in all batches, the mix was 1:3, consistency normal, and the cylinders cured 22 hours in a moist closet and 20 days in distilled water before immersion in the solutions. The cylinders were made in batches of 8 to 13 and one from each batch tested for compression at 7 and one at 28 days, while the standard drying and 5 hours boiling test for absorption as required for drain tile was made on one cylinder from each batch at 21 days—the age when immersed in the solutions.

Results of Tensile Tests.—Tensile tests were made on standard briquettes made from this sand. The results of these tests follow:

TABLE I—STANDARD OTTAWA SAND
(Pounds per square inch.)

Compression (2"x4" cylinders).			Tension (standard briquettes)		
No. of cylinders	7 days.	28 days.	3 days	7 days	28 days
20	2110	2955	133	205	308

Average absorption of 16 cylinders at 21 days, 7.6%.

TABLE II—MINNESOTA SAND SCREENED 20-30
(Pounds per square inch.)

Compression (2"x4" cylinders).			Tension (standard briquettes)		
No. of cylinders	7 days.	28 days.	3 days	7 days	28 days
9	880	1430	89	144	216
Strength ratio ...	0.42	0.48	0.67	0.70	0.70

Average absorption of 7 cylinders at 21 days, 15.9%.

TABLE III—PIT RUN MINNESOTA SAND
(Pounds per square inch.)

Standard Ottawa sand			Minnesota sand		
3 days.	7 days.	28 days.	3 days	7 days	28 days
133	214		[illegible]	238	314
		Strength ratio	[illegible]	1.11	1.02

The Minnesota sand cylinders as made up represent essentially a low grade concrete as indicated by all the physical tests, but the fact must be borne in mind that the screening of this sand is unusual so that in this respect the strength ratios given are somewhat misleading and the following results of tensile tests made of the pit run material passing a ¼-in. screen gives a fairer idea of the general quality of the sand as ordinarily determined.

When the cylinders were made up brass screws ¾-in. long were inserted in the center of the top and bottom faces. These screws were put in place three or four hours after the cylinders were molded and were set in neat cement. The object of this was to provide means whereby measurements could be made at regular intervals between the heads of the screws in order that a record could be had of the change in length of the specimens after immersion in the sulphate waters.

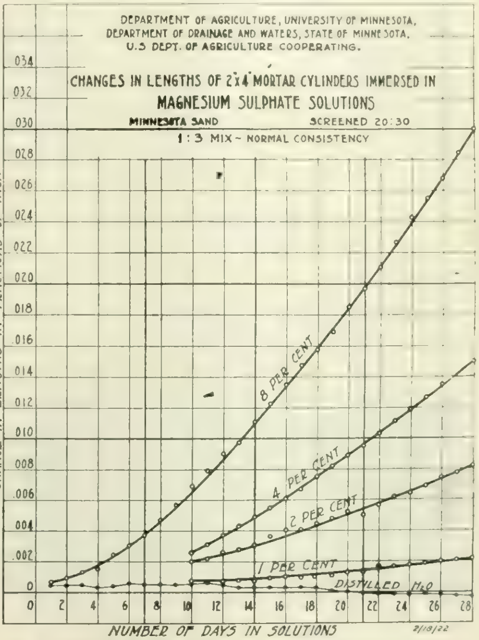


Fig. 1—Changes in Length of Mortar Cylinders Immersed in Magnesium Sulphate Solution.

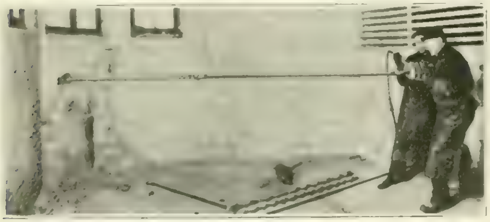
Swelling of Concrete in Presence of Sulphate Waters.—Various investigators have noted that disintegration of Portland cement concrete in the presence of sulphate waters has been accompanied by an increase in volume of the mass. This fact was mentioned by the writer in the paper before the Minnesota Society a year ago wherein it was stated that the increase in volume in extreme cases of failure of concrete tile had been considerable and as a matter of fact the most outstanding physical feature connected with these failures was this swelling of the concrete. It early occurred to the writer that in research work this characteristic might be made to render valuable service if used as a means to determine in a recordable manner long before complete failure the deterioration of the concrete, for with such a means at hand the possibilities for experimental work, looking towards the ultimate solution of the problem, are multiplied many times.

The results of the first set of a series of experiments along this line have been highly gratifying and, while there is no desire at this time to attempt to draw definite conclusions from one set of experiments, it is interesting to note the remarkable uniformity with which the action has progressed in the Minnesota sand cylinders immersed in the 1 per cent, 2 per cent, 4 per cent and 8 per cent solutions of magnesium sulphate. This is indicated by Figure 3, on which also is shown the results of measurements of comparative cylinders immersed in distilled water. Each point on these curves represents the average of five specimens made on different days so that for each date the measurements were made on five different days.

The solutions have been held at room temperature of 68-70° F. and, as indicated by thermograph records, there have been no extreme departures from these figures. The results of the effects of the solutions below 1 per cent have not yet been plotted, for so far the changes of the cylinders in these have not been pronounced and are more erratic than has been the case with those in the richer solutions. This of course was as would be expected. What is important, though, is the fact that at the end of 28 days the changes of the Ottawa sand cylinders have been very slight and even the cylinders in the 8 per cent solution show an average change slightly less than one thousandth of an inch which is only about one thirtieth as great as has been the change of the Minnesota sand cylinders in the same strength solutions. (See Fig. 10.) Now when the difference in the quality of the two types of cylinders, as indicated by strength and absorption as earlier pointed out, is considered it becomes evident that, in this case at least, the concrete highest in quality has best withstood the deleterious action of magnesium sulphate and there is every reason to believe that this will apply as a general proposition.

Use of Pneumatic Hammers and Coal Drills in Installing Service

A decided saving in the cost of installing services was effected by the use of pneumatic tools in some tests conducted recently by the Brooklyn-Edison Co., Brooklyn, N. Y. In these tests chipping hammers and coal drills were used for drilling holes under the sidewalk from the cellar to curb in the service pipe, thus doing away with the necessity of breaking sidewalk flags and excavating as would be the case with hand methods.



Drill Fitted With Extension Bar for Final Drilling Operation.

According to the report of the engineer conducting the tests the approximate saving based on actual costs for drilling and driving pipe for 53 services was $12.70 per service. This amount represents the labor saved on pipe installations and the labor, trucking and material saved on sidewalk repairs.

The tests covered the installation of 53 services requiring 1,450 ft. of service pipe. Of this total 1,006 ft. were driven by pneumatic tools and 444 ft. were laid by hand methods, the latter work involving opening flags and excavating. Comparative figures from the report on the installation of service pipe follow:

	By pneumatic tools	By hand
Service pipe, ft.	1,006	444
[illegible]	67	
[illegible]	[illegible]	[illegible]
[illegible]		*[illegible]
[illegible]		
[illegible]		[illegible]

*[illegible]

The pneumatic tools used in the test were Little Giant coal drills and Boyer chipping hammers, manufactured by the Chicago Pneumatic Tool Co., New York. The accompanying illustrations show four distinct operations in drilling from the basement to curb preparatory to installing the service pipe.

Cutting Opening in Basement Brick Wall With Chipping Hammer, Through Which Drilling Operations Will Be Performed. Middle View—Initial Drilling Operations With Air Drill. Bottom View—Second Drilling Operation, Bore Carried to a Depth of 10 Ft.

Problems, Progress and Prognostications from a Half Dozen Cities

Varying Conditions Legislative Limitations Suggestions for Engineers

St. Paul Engineer Blames Special Assessment System for Stopping Much Work, But Has Busy Year in Prospect

Acknowledging receipt of your letter relative to municipal construction which has been held in abeyance.

It seems that the trouble is because of charter or legislative requirements in most cases. For instance, the charter of the city of St. Paul requires all new improvement work, such as sewers, grading, paving and curbing, shall be financed by special assessment on the property benefited, and in times of money stringency it is very difficult to get the people affected by proposed improvements to acquiesce in having the work done. We find that there is no trouble in getting their consent in cases where they do not have to pay for it, but such instances are very rare.

The partial cessation of building activities, combined with the high cost of improvements, has reduced the demand for street improvements in new districts to almost nil. Improvements in the more settled districts have gone forward as much as usual and the present indication is, from our point of view, that the pendulum is swinging the other way and we expect a very busy year in all lines of construction work.

J. E. CARROLL,

St. Paul, Minn. Assistant Chief Engineer.

Lack of Funds Limits Work at Mansfield, Ohio, and Legislature Fails to Improve Conditions.

I have read with interest your editorial and letters in the March issue pertaining to municipal improvements, and will try to explain why we cannot undertake any municipal improvements which will place any cost on general taxes. You will find this an average condition in Ohio cities generally.

This city pays in general taxes this year approximately $900,000. The county, state, township and schools take out a certain per cent first and we receive what is left, and therefore have $40,000 for operating expenses for the coming year. Any interest for city bonds would have to come out of this money indirectly. Now our street lights alone cost $25,000 per year, and you can draw your own conclusions.

The state legislature has worked (?) for about four years to give relief, even sitting in special sessions with the marvelous result of passing some laws that make it more difficult to operate on what we receive, so that now it is a fairly safe bet that the majority of cities in this state will have to operate illegally after June or quit entirely.

W. C. STATLER, City Engineer

Mansfield, Ohio

Consistent Progress in Walks and Pavements Marks Past 10 Years at Fall River

The following figures show some of the items of highway construction work by this city for the past 10 years. From them you may be able to deduce the information requested by your letter of March 11:

	Granolithic walks. Sq. yds.	Sewers Miles.	Paving. Sq. yds.	Curbing Miles.
1912	20,742	1.263	16,126	4.41
1913	21,822	2.012	3,204	3.10
1914	25,791	2.825	11,962	3.09
1915	32,986	2.124	54,209	3.94
1916	19,620	2.098	77,567	4.70
1917	28,436	1.268	80,358	3.82
1918	3,749	0.368	11,381	0.13
1919	28,321	1.024	136,862	4.57
1920	23,406	1.059	118,915	4.53
1921	12,758	1.785	155,658	6.54

ALBERT WOLSTENHOLME,
City Engineer.

By Walter E. Noble, Assistant City Engineer.

Fall River, Mass.

Maintenance and Legislative Limitations Constitute Main Difficulties at Fargo.

Your editorial in the March 8 issue of Engineering and Contracting came to my attention just as I succeeded in getting the Board of Commissioners to approve plans and specifications for $25,000 worth of water main work. There was considerable objection raised to doing the work at this time as it consists entirely of replacing existing mains that are either in a leaky condition or beyond repair and of too small size.

Our main difficulty, however, is not with new construction, but with maintenance. Nearly all public work is paid for by special assessment of the property benefited and is not paid for by general taxation, but the various department expenses are paid for out of the department budgets, which are effective from Sept. 1 to Sept. 1. A legislative act (Nonpartisan) passed March, 1921, limits the total amount of taxes levied to one-third the total combined levies which were made for the years 1918, 1919 and 1920, and provides for a further increase each year in the same proportion as the assessed property valuation increases or has increased over that of the year 1919. In 1919 the assessed valuation was approximately $23,000,000, while in 1921 this figure has been raised to about $25,000,000. From this it is seen that the city is forced to operate most economically in order to keep within the tax limit. The history of this tax levy act might prove interesting material for an article.

Under the present program we will lay about 15,000 sq. yd. of paving and make changes in our water purification plant amounting to about $40,000. This latter work will be done by day labor under the writer's supervision.

ROBERT T. JACOBSEN,

Fargo, N. Dak. City Engineer.

Paving in Arrears: Water Plant Well Maintained at Helena During Past 5 or 6 Years.

Five or six years ago our plans for street improvements were well under way, but for the last four years there has been no paving done, principally on account of excessive cost of labor and materials.

Our water supply has been kept up in good condition, having spent during 1920 $150,000 and $200,000 during 1921.

The paving problem should be solved by making provisions for extensive construction during the next two or three years.

At the present time very little is being done to insure the carrying out of any extensive improvement plans.

A considerable reduction in the price of cement, and bituminous products and the stabilizing of labor conditions would help to bring a general resumption of municipal construction. A. E. CUMMING, City Engr.

Helena, Mont.

Freedom from Politics Gives Power to Hartford's Department of Engineering.

The Department of Engineering of the city of Hartford enjoys the unique distinction of being absolutely removed from politics. This fact, I believe, more than any other accounts fundamentally for the position of trust and respect which the department holds in the community.

The City Engineer acts as adviser and may be consulted by all other city departments, boards and committees and citizens, and therefore plays an important part in formulating the policies of the city. The press makes a practice of interviewing the City Engineer and of quoting him relative to many matters of public interest. Under these conditions it seems to me that the citizens are getting the advantage of engineering counsel and advice in a manner that perhaps cannot be improved upon.

It is becoming the practice more and more to fill city and state positions with engineers and the results of this practice is apparent.

I have sat in with engineering bodies and listened to suggestions and schemes whereby the society would take upon itself the responsibility of passing on all important matters which are before the people and of influencing public opinion. It sounds very well, but I doubt if any such scheme can be carried out and continue to work successfully for any considerable time. I feel that matters outside of local engineering problems can be left to the individual as a free thinker and that engineers as individuals in their daily walks of life can accomplish as much good as a [illegible] whose purpose may be misunderstood.

It certainly could do no harm for engineering meetings to consider questions of the day and to educate the membership to the condition of affairs and of their duty as professional members of society, but [illegible] a report in the press of the doings of the meeting. I feel that the societies should not go, at least as a society, [illegible].

If municipal and state engineering departments could all be freed from political influence I am sure that the work of the engineer would be more effective and that society would benefit because of the fact that he would be in position to think and speak his mind freely and fearlessly.

R. J. RASS, Asst. City Engineer.

Hartford, Conn.

What Baltimore Is Doing in the Way of Public Work

The accompanying tabulated statement shows the amount of money spent on construction by five of the principal departments of the city, also the total amount spent for the years from 1914 to 1921 inclusive, as well as the total appropriations available for the year 1922.

EXPENDITURES FROM 1914 TO 1921

Year	Paving	Sewers	Water	[illegible]	[illegible] repairs	Total expenditures of city.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Appropriations for 1922.						
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6,790,000	73,000,000

The paving commission has its program for the year nearly completed and they expect to construct 450,000 sq. yd. of paving this year.

The sewer division has its plans nearly completed for the sewering of several large districts which will soon be placed under contract. They will also acquire a number of private sewers and connect them up with their main system.

The year 1921 has been the greatest year in the history of the water department. During the year the city acquired several private water companies, at a cost of about $3,000,000. They also made a record in the amount of new water mains laid. During the year they put under construction the raising of the Lock Raven Dam from an elevation of 188 ft. to 240 ft.; this dam will be completed during the present year.

In connection with the raising of the Lock Raven Dam, the city of Baltimore has acquired the cotton mills at Warren and Phoenix at a cost of $1,000,000, and the acquisition of other property that will be submerged will cost half a million more. In the neighborhood of Phoenix the Northern Central Railroad will be raised at a cost of approximately $250,000.

There are several highway bridges to be built and about four miles of improved roads. When the dam is completed there will be about 2,500 acres of land submerged and 22,000,000,000 gal. of water impounded.

The school program for this year will probably go far beyond anything in the history of Baltimore. At the present time one large school building is under construction and the plans for 11 others are in the hands of the architects and will be completed and ready for occupancy during this year. In addition thereto $1,000,000 has been appropriated for school repairs. While this is insufficient to do all the repair work necessary, it will go a long way toward relieving the congestion in our schools.

Construction work outside of the municipal construction is keeping pace with that of the city. So far this year, the inspector of buildings has granted permits for the construction of [illegible] dwelling houses and 200 garages.

As a means for relieving unemployment the city arranged to repair roads, lay water mains and do such sewer work as could be done in freezing weather, by employing the men that were badly in need of work, and in order to take care of these men they organized the municipal employment bureau, [illegible] men were registered and as men were needed, those needing help the most were put at work. Since the organization of this bureau on Oct. 10, 1921, 7,200 men were registered, 2,710 were found employment, and of these nearly 1,000 were given work by the different city departments. At the present time the bureau is unable to fill all the requests for laborers.

S. I. KEHLER,
Associate Civil Engineer.

Prevention of Electrolysis Troubles in Water Mains

Electrolytic Problems and Methods of Mitigating Them Discussed in Paper Before California Section American Waterworks Association

By E. B. STEWART,

Electrical Engineer, East Bay Water Co., Oakland, Calif.

Methods of Reducing Damage to Pipes.—In an effort to reduce or eliminate damage to pipe systems due to stray earth currents, a great many methods are in use.

Those methods which are commonly used are: (1) Surface insulation of pipes, (2) insulating joints, (3) pipe drainage systems.

Experience has shown that painting or otherwise insulating the surface of pipes by the use of treated paints does not give satisfactory results in areas where the pipes are carrying a large amount of current.

The primary reason for failure of paints under this condition lies in the fact that none of the paints, as you all know, are absolutely impervious to moisture. Consequently, as moisture deteriorates the paint, the paint becomes more conducting for electric current, resulting in the formation of more or less gas beneath the coating. As this gas increases in amount and expands, the coating is ruptured, after which the current flow is greatly increased at the point of breakdown resulting in rapid electrolytic corrosion of the pipe.

Pipe Drainage System of Electrolysis Mitigation. The system of electrolysis mitigation which is most generally used is the pipe drainage system. This system is employed in a variety of forms, the principal ones being as follows:

1. Where direct ties with wires or cables are made between underground pipes and rails.

2. Where uninsulated negative feeders are run from the negative bus to the pipes.

3. Where separate insulated negative feeders are run from the negative bus to underground pipes with resistance taps taken off at intermediate points.

Of these systems the simplest and least extensive system is that of placing direct taps to the pipes in the positive zone. One difficulty of this system of multiple taps lies in the fact that the drop of potential on the pipes is always equal to the potential of the tracks. In other words, if the rails carry a large amount of current, a heavy current will also be produced in the pipes, and in case high resistance joints are encountered a large amount of current will cause heavy leakage around the joint and cause rapid destruction to the pipes. In case of a broken bond in the track system the amount of current will be considerably increased.

The primary object of drainage by means of uninsulated and insulated negative feeder systems is to keep the pipe drainage system entirely independent of the tracks so that the flow of current around bad joints in the pipes will be less serious.

Fundamentally, this system consists of running copper cables from the negative bus parallel with the pipe and tapping to the pipe at frequent intervals.

By the use of resistance taps the current can be controlled so that an equal distribution of current is drawn from the different taps. In this way a better distribution of the current in the pipe system can be secured and heavy current on the pipes at any point can to a certain extent be avoided, and at the same time reduces to a minimum the cost of copper cable.

Another method of pipe drainage system is that of running different feeder cables from the negative bus and tapping to the pipe at frequent intervals. In this case the feeders are designed so that practically the same amount of current will flow over the feeders from each tap and thereby produce a minimum drop of potential between points at which the taps are connected.

These systems in general practice, however, are seldom employed in the manner as outlined above. The most common practice is to run a copper wire or cable from the negative bus or from the negative return feeder to the pipe. In many cases pipes are connected to the rail near the substation, and very often, connections are made to the rails at points considerable distance from the station.

From a personal study of the pipe drainage systems, I am convinced that, while it can, under certain conditions, be used to advantage as a secondary means of lessening trouble, its installation in large city waterworks as a principal means of electrolysis mitigation is an unwise procedure. There are, however, certain special cases where the pipe drainage methods will give fairly good results. This applies particularly to suburban areas where the pipe networks are small. Under this condition, limited drainage may offer the best means of dealing with the problem, provided there is no appreciable leakage of current from the rails at remote points from the power station.

Disadvantages of Bonding to Rails at Points Remote from Power Station.—Bonding to the rails at remote points from the power station is out of the question and should not be resorted to. As an illustration of the disadvantage of this system, we have a case where the pipe line crosses under the rails at a point 2,900 ft. from the power house. The reason for placing a bond at this point was obviously due to the fact that tests with an indicating meter showed the pipe to be of positive potential to the rail, and the conclusion arrived at, therefore, was that lowering the potential between the pipe and rail would relieve the pipe from electrolytic corrosion. Shortly after placing the bond to the rails at this point, trouble began to develop very close to the point where the bond was connected. No account, however, was taken of the potential of the rails with respect to the earth and also the reversal of current flow from the rails to the pipes during certain changes in the load distribution. The rails at such distances from the power stations are generally always of positive potential to the earth. It is therefore clear that while the bond has removed the discharge of current from the pipe to the rails, the pipe is still positive to the earth, i. e., the pipe is of the same potential to the earth as the rail by reason of the bond connection. Hence the increase of current over the bond produces a heavy discharge of current into the earth causing destruction in a short period of time.

To mitigate a condition of this character involves considerable expense regardless of which plan is to be employed. To attempt to correct this trouble by the proper drainage methods would not only be costly but rather uncertain, especially without certain remedial measures to be taken by the railway people. Fundamentally a drainage wire to accomplish the desired results in this case must be connected very close to the power station which would result in considerably more current being drained from the pipe, and perhaps the increase in drainage would be of such magnitude as to produce little or no change in the potential readings at the rails, hence there would be no benefit derived from this plan. In other words, the closer the drainage wire is connected to the station, the amount of current picked up from the earth will increase in like proportions. And in long drainage wires the size of the wire would necessarily have to be very large in order to maintain a drop of lower potential than the rails.

I believe that the most safe and economical plan to mitigate cases of this character would be to enclose the pipe in a wooden conduit and to fill it with insulating compound. While this plan is costly, it serves a double purpose, i. e., the trouble is not only corrected at the rail, but trouble is also minimized to a certain degree, at points remote from the rails due to the fact that insulating the pipe will cause a smaller amount of current to accumulate on the pipe in outlying areas.

Another case of somewhat similar nature is where the pipe runs parallel with the rails and is connected by a drainage wire to the negative bus. This pipe is seriously affected at a remote point where the pipe crosses and runs in very close proximity to the rails.

To mitigate this case by the drainage method would necessitate extending an insulated drainage wire from the negative bus to a point in the affected area. This plan would meet with the same objections as in the previous case.

Objections to Pipe Drainage System.—One of the objections to the pipe drainage system, and this applies to all methods that are in practice, is the fact that they are designed to relieve the symptoms and do little or nothing towards removing the cause of the trouble.

A serious objection to pipe drainage is to be found in the interchange of current between underground structures, resulting from unequal drainage. The drainage of one system of pipes will of course lower its potential with respect to the neighboring metallic structures, thereby tending to injure the latter. This in turn calls for drainage of the injured system, which may damage the first or other structures and consequently, a system of competitive draining is established.

This competitive system of drainage requires constant watching, as changes and extensions to the system will establish added points of hazard to the system.

Another difficulty lies in the fact that structures owned by different interests cannot be bonded together except by an agreement between the owners. This very often of itself makes it impossible to apply a comprehensive drainage system to all structures, because of the impossibility of obtaining an agreement of all owners to allow connections to their structures except on condition that another interest assume the liability for any injury which may result from such connections.

In the early stages of the practical working out of the drainage system, the effect of its application is apparently beneficial, reducing danger in positive areas more than it increases it elsewhere.

As the system grows, the load increases; more and heavier bonds become necessary and the current in the pipes may become so great that any further extension of drainage will become a menace to the system. It is largely due to this slow and obscure manner in which trouble develops that has caused this method to be so widely used. That is, the placing of additional bonds between pipes transfers the trouble from where it has been most evident to a new location, where it may require several years to manifest itself anew. Hence the intervening lull which creates a favorable impression is sometimes difficult to dispel even when trouble later occurs.

Another disadvantage of the drainage system is that phase of electrolysis of water pipes which is caused by overdrainage of underground cable systems.

Pipes as a rule are much closer to cable conduits in the ground than they are to rails. In many cases they are but a few inches apart, and in some cases rest directly against the conduit. Under such conditions, where both metals are in wet soil, a low difference of potential, say a few tenths of a volt, is often sufficient to carry current and to cause damage to main or service pipe.

It is a most difficult matter to insulate underground cables even with the most improved type of conduits, so as to prevent current flowing from pipes into them, especially when they are near points where the cables are bonded to railway negatives.

The natural attraction for current flowing upon water or gas mains is directly to the conduit, either from the mains or services. This is the case also with hydrant branches and pipes that pass into side streets. In other words, the cable conduit threads its way between gas and water services as they pass into buildings along a street.

Damage to Pipes on Streets Where There Are No Tracks.—It happens often that pipes are damaged upon streets where there are no tracks. As a matter of fact, the tracks have nothing to do with this feature of electrolysis. In one case where a number of services were found to be leaking, investigation developed that a cable conduit passed directly under them. The services were one-tenth of a volt positive to the cables. In this case the soil was wet clay and the nearness of pipe to the conduit made up for the comparatively low potential to destroy the pipe.

This phase of electrolysis, therefore, shows the necessity of conducting tests between pipes and underground cable systems. Ordinarily this phase of electrolysis would not be suspected, as tests between piping systems and rails would not indicate that such damage was going on.

In laying service pipes, it is advisable to keep the pipes as far away from cable conduits as it is possible to do so, because there is no telling how the currents will flow along the pipes and pass out of them at any convenient point, and generally the point which is nearest the conduit is where the most of the current will pass, but if it is wet clay, then a sufficient amount of current may pass to cause electrolysis corrosion.

Insulating Joints as Mitigative Measure.—The most valuable mitigative measure I believe that can be applied to pipe systems consists in the proper use of insulating joints. We believe the extensive use of such joints should be encouraged in new **work and in making repairs.**

There are many who criticize this method from the standpoint that current will flow around the joint and cause destruction of the pipe on the positive side of the joint. It is quite true that trouble of this character will arise and cause destruction of the pipe provided the joints are indiscriminately placed without regard to their frequency, the kind of **joints best suited to certain conditions, and the complication** arising from the presence of other pipe systems not so insulated. **All of these are important factors and must be carefully taken into consideration if adequate protection is** to be secured. It should be further understood that insulating joints should be considered as an auxiliary in connection with and supplementary to measures to be applied to railway return systems for reducing stray currents to the lowest possible minimum. While it is not always possible to reduce **economically stray current from the rails, it is nevertheless** advisable to obtain data to show a fairly good idea of the nature and extent of stray current from the tracks.

As a general rule where a pipe line is laid with about every fourth or fifth joint an insulating joint, the line has such a high electrical resistance that no measurable current flows on the line, although considerable current exists in the earth parallel to the pipe line.

Placing insulating joints at too infrequent intervals is probably responsible for a good deal of disfavor of this system. Obviously if the joints are placed far apart, the long stretch of intervening pipe may pick up considerable current. **Since this current must flow out of the pipe as it approaches the insulating joint, serious electrolytic corrosion may occur** on the positive side of the joint. The more frequent the joints are placed, the less damage will occur from this source.

In these installations we find that it is necessary to install such insulating joints not only in the positive areas but also in the negative areas where considerable current in the earth parallel to the pipe exists.

In connection with the installation of insulating joints on wrought iron and steel pipes, it has been found necessary to increase the length of the joint by surrounding the joint and pipe with a wood box, leaving a space inside to be filled with insulating compound. The length of the boxes depends upon **the resistance and amount of current in the soil.**

Enclosing insulating joints does not materially increase the resistance of the joints but a long insulating joint gives a **more even distribution of leakage current than a short joint.** A long insulating **joint, therefore, is to be preferred when** there is considerable potential across the joint or where the resistance of the surrounding soil is very low.

In a number of installations we found considerable current to flow around the joints, due to service pipes being in physical connection with gas services at the houses. This trouble was corrected by inserting an insulation joint at the service meter.

In some cases, however, it was found necessary to install an insulating joint in the service at the main and also a second joint at the meter. The necessary location of these joints must be determined from the results of electrical measurements.

We find the flanged type of joint the most desirable and economical joint to be used on wrought iron and steel pipes. This insulating joint has been made up of a disc insulating material between the surfaces of the flanges, and placing insulating washers under the bolt heads and nuts. Red or gray fiber has most commonly been used for insulating material.

For cast iron water mains with bell and spigot joints we use a short wooden ring between the inside of the bell and the end of the spigot to prevent metallic contact between the pipe lengths, and then we caulk the joints with cement. The bead of the spigot end of the pipe was removed.

We find that the current in the pipe is considerably reduced by the use of cement joints. This, however, does not in all cases prevent electrolytic corrosion in localities where current can reach the pipe by way of laterals or where it is closely adjacent to other conducting structures or when there is leakage from another transverse pipe.

In the practical working out of the various systems of electrolysis protection the conditions of the railway systems are usually ignored. I believe that a more logical and, at the **same time, effective and economical procedure to handle the** problem is first to obtain a general working knowledge of the railway systems, that is, a knowledge concerning the load **factors of the various power stations, the operating time of** each station and a general knowledge of the leakage currents **from the rails. From certain electrical tests it is possible to** calculate the probable distribution of the leakage currents from the rails and to locate the places where there is a probability of electrolytic corrosion.

In order to obtain such information with any degree of accuracy, it is quite necessary that co-operation exist between the railway companies and owners of underground utilities.

Industrial Notes

The Combustion Engineering Corporation, New York, announces the opening of a new branch office at 113 Guardian Bldg., Cleveland, O. This office will be in charge of Frank Henderson.

The Chain Belt Co., Milwaukee, Wis., has announced the appointment of G. F. Sherratt as manager of the Pittsburgh office in the Union Arcade Bldg. Mr. Sherratt will be in charge of all **the company's chain** and conveying business in the Pittsburgh territory and is equipped to render engineering service on power transmitting and material handling problems. Chain Belt Co. specializes on chain and material handling equipment for all industries. The products of the company are manufactured under the trade name of "Rex." The Ward Equipment Co. of Pittsburgh will continue to handle the complete line of Rex concrete mixers and pavers, and the [illegible] Equipment Co. the Rex traveling water screens.

The annual meeting of stockholders and board of directors of the Austin Machinery Corporation was recently held in Richmond, Va., and New York. The board of directors, consisting of B. A. Linderman, Ralph Crews, C. L. Hollister, Samuel McRoberts, C. A. Peckham, John R. Shaw and Hon. C. W. Watson, were elected. **Officers elected were as follows: B. A. Linderman, president**; John R. Shaw, vice-president; William Wertz, secretary; J. R. Van Keppel, treasurer. The executive committee consists of Samuel McRoberts, Ralph Crews, Hon. C. W. Watson and B. A. Linderman. The company reports unusual expansion in the sales organization and many additions to its already expansive line of **road building, excavating, irrigation and** contractors' machinery.

Increasing activity in the power and railway divisions of the Pittsburgh office of the Westinghouse Electric & Mfg. Co. has resulted in the separation of the two divisions and some new appointments in personnel of management. Barton Steveson, who has been manager of both divisions, will continue as manager of the power division and will devote his entire time to activities in connection with that unit. F. G. Hosking has been appointed manager of the railway division, the appointment becoming effective immediately. S. R. Shave has been appointed manager of the price section of both the power and railway divisions in the Pittsburgh office. The separation of the two divisions under different heads will facilitate the handling of both power and railway business.

Statement of the Ownership, Management, Circulation, Etc., Required by the Act of Congress of August 24, 1912.

Of Engineering & Contracting, published weekly at Chicago, Ill., for April 1, 1922.

State of Illinois, County of Cook, ss. Before me, a notary public in and for the state and county aforesaid, personally appeared Lewis S. Louer, who, having been duly sworn according to law, deposes and says that he is the Vice President of Engineering & Contracting, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor and business managers are:
   Publisher, Engineering & Contracting, 9 S. Clinton St., Chicago.
   Editor, H. P. Gillette, 9 S. Clinton St., Chicago.
   Managing Editor, H. P. Gillette, 9 S. Clinton St., Chicago.
   Business Manager, Lewis S. Louer, 9 S. Clinton St., Chicago.
2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.) H. P. Gillette, 9 S. Clinton St., Chicago; Lewis S. Louer, 9 S. Clinton St., Chicago; Richard E. Brown, Columbia Bank Bldg., New York, N. Y.
3. That the known bondholders, mortgagees and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages or other securities are: (If there are none, so state.) None.
4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association or corporation has any interest direct or indirect in the said stock, bonds or other securities than as so stated by him.

LEWIS S. LOUER, Vice-President.

Sworn to and subscribed before me this 29th day of March, 1922.
(Seal.) H. NELSON, formerly H. DANNER.
(My commission expires Dec. 3, 1922.)

Railways and Excavation Monthly Issue

ENGINEERING AND CONTRACTING

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
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(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
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(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
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(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Managament and Office System

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A Public Utility Commission That Regards 5% as a "Fair Return"

A few years ago, at a time when interest rates were far below the present average, a certain state public utility commission ruled that 6 per cent was a "fair return" rate for a public utility. That decision was quite generally regarded as approaching pretty close to the limit of confiscation set by the Supreme Court. Now comes the Illinois Commerce Commission with a decision cutting the fares of the Chicago street railways to a point that would yield 5 per cent on an extremely low "valuation."

We are inclined to regard this decision as an example of extreme ignorance of economics. Otherwise we are unable to explain the complaisancy with which the commission gives its reason for using a 5 per cent return rate. The argument is that the average interest rate on the bonds of the street railway company is almost exactly 5 per cent. Laying aside for a moment the fact that stock almost always sells at a price to yield a higher interest than bonds, let us consider the 5 per cent interest on the bonds of the Chicago City Ry.

The first mortgage 5 per cent bonds of this company are now selling at 80 ct. on the dollar, in spite of the fact that they mature in 1927. Hence a purchaser of these bonds can secure a yield of more than 9 per cent on his investment if the bonds are redeemed in 1927. Although these bonds yield 5 per cent on their par value, they do not now sell at par, and it is probable that they were originally marketed at less than par, so that there is no economic justification for using the 5 per cent rate in their par "value" (which isn't value at all) as a criterion of "fair return."

An equitable way of ascertaining a fair return rate for that part of a railway property that is mortgaged would be to ascertain the average present yield on investments in bonds of a similar nature. This exceeds 6 per cent in cities where the utility companies are accorded liberal treatment by the representatives of the public. In cities where such treatment is not accorded, the yield on such bonds exceeds 7 per cent.

But only a part of the money invested in a public utility company is secured by the sale of bonds. Usually 40 to 50 per cent is secured by the sale of stock, and since the risk involved in stock investment is greater than that in bonds, stocks usually yield 1 to 4 per cent more (on their selling price—not on their par value) than the bonds yield, the amount of the difference depending largely upon the amount of the prospective net earnings in excess of fixed charges and taxes.

Occasionally a public utility commission has stated that under commission regulation there is practically no greater risk on stock investments than on bond investments, supporting such a statement by pointing to the fact that the commission protects the company from competition and "assures" a continuity of the net earnings. The answer to this argument is that what an investor demands is not assurance but insurance, and that insurance is precisely what a commission can not give, not even for the term of office of the commissioners. Where was the insurance when jitney bus competition began to make deep inroads upon the earnings of street railway companies? How can a commission prevent people from owning private automobiles, motorcycles, etc., and preferring to ride in them to riding in street cars? How can a commission prevent a city from building a competing street railway, as San Francisco has done and as Detroit is doing? A dozen other questions of like nature rise in our minds, but there is no need of framing them, for the fact is that the investing public has always refused to believe that any public utility commission gives the insurance needed to justify putting capital into public utility stock on a yield basis as low as that on bonds. After all it is not public utility commissions who fix rates of fair return on capital. They may name a rate and call it 'fair,' as for example the 7 per cent rate now under discussion, but investing public may repudiate the rate so named, as witness the present selling prices not only of bonds and stocks of the traction companies of Chicago, but of other utility companies throughout America.

"Depression Need Not Continue"—A Criticism of a Brother Editor

Under the quoted title the Manufacturers' Record recently published an editorial article that is a curious mixture of wisdom and ignorance, the wisdom fortunately predominating. The ignorance, however, is so conspicuous and of such a common character as to call for comment. We refer to the misunderstanding of the meaning of the term "natural law." However, before discussing the error, let us quote the editorial article in full:

> It is a favorite pastime of professional economists to draw charts showing the course of prices over past eras, and these [illegible] demonstrating [illegible] that during great wars prices have climbed to new heights and that after great wars they have declined more or less rapidly. Therefore, argue these economists, it is evident that there is a natural law which [illegible] and made necessary the appalling depression of recent months.
>
> It is amazing how much [illegible] and [illegible] to think some [illegible]. Imagine what laughter would greet a physician who seriously produced charts to show what the course of yellow fever had been in the recurrent epidemics of the nineteenth century, and predicated on them a prophecy that during the next ten years so many thousands of good Americans would inevitably be victims of the yellow scourge!
>
> Science has taught us how to defeat yellow fever. Charts of economic disaster should be valuable only as demonstrating the necessity of formulating measures to prevent such disasters. Instead, they are offered as proof why we should be quiescent under [illegible]. We have nothing but contempt for the intelligence of men who take the view of inevitability. Human experience in all other directions is to the contrary. Financiers who preach the [illegible] of panics are mere creatures of text books [illegible]. Not one of them would ever have invented an internal combustion engine or have devised a reclamation project.
>
> We have no faith in those who desert civilization and barter the future for their present gain. May we be saved from those who argue that prosperity is at the end of a pendulum and must swing into ruin. The thermometer does not control the weather; the weather controls the thermometer. Trade is the thermometer to which weather is the human intelligence. If the mercury freezes, it is not nature that is responsible, but the intellectual incapacity [illegible] of the gentlemen in control of affairs.

None but very ignorant economists regard a "natural law" as one that controls events as man-made law aims to control conduct; but apparently the Editor of the Manufacturers' Record regards a "natural law" as if it were a compulsory mandate of a supreme power. A natural law, however, is nothing but a statement of what effects follow certain causes. The inevitableness of the result is there only when the same causes are there.* A natural law tacitly, if not avowedly, assumes the existence of certain causes, and then it states the consequences. There is no such thing as the suspension of, or interference with, a natural law, for the law itself is not a force or group of forces, but merely a statement of the manner in which forces interact.

The editor of the "Record" inveighs against passive resistance to present economic conditions, and in that he is perfectly sound; but when he derides statistical interpretation of past events and scouts the ability to forecast the economic future from statistics, he is entirely wrong. The economist, for example, who shows that wage levels are dependent on money levels, and who proves that per capita money and average wages have gone hand in hand during the past century, announces an economic law, but he does not say that man can not, or should not, regulate the quantity of money. He does not bow to a natural law as to a sacred edict. On the contrary, he is the very sort of person who is most likely to tell the public what should be done to relieve bad economic conditions. He it is who shows the world how to prevent excessive fluctuation in wage and price levels by controlling the supply of money in circulation.

We fear that our brother editor has seen too many price index charts and has read too little of the interpretations thereof by scientific economists. There is a veritable deluge of writings on price levels by men who have no scientific training. Perhaps it was the foolish utterances of such writers that gave our brother editor the inspiration for his imprecations.

And Mayor Thompson Shouted———

"They say we can't have a nickel fare in Chicago," shouted Chicago's mayor in a recent speech. "They have it in New York with privately owned lines. They have it in San Francisco, with public ownership, and don't let anybody tell you we can't have it here under the Thompson plan. I ask you for a majority of ten votes in the Senate to see that the traction interests do not fool you for a second time."

For several years Mayor Thompson of Chicago has campaigned on a platform consisting of a single plank—a nickel carfare. When the Illinois state public utility commission refused to grant the nickel fare, but had the courage to put into effect an 8-cent fare, the mayor of Chicago, aided by other politicians, succeeded in electing a governor who promptly got rid of the utility commissioners and appointed successors. These successors lost little time in ordering a 5-cent street car fare in Chicago, but the Federal Court granted an injunction when it was shown that operating expenses alone amounted to 6 cents per passenger. A few days ago the state utility commissioners ordered "a 6-cent experimental fare," and now another federal court hearing is pending. However, we are less concerned with the question of car fares in Chicago, than with the statement of Chicago's mayor that San Francisco and New York have nickel fares, and that, by inference, Chicago should have a nickel fare. But the mayor failed to tell his audience that the San Francisco municipal railway is earning next to nothing on its cost if allowance is made for depreciation and lost taxes. He also failed to tell his audience that the New York traction lines are on the verge of bankruptcy and that their stock is selling at so low a price as to indicate little hope on the part of the stockholders. Moreover, he failed to tell his hearers that the mayor of New York is his political Siamese twin, and has done everything in his power to prevent the New York traction companies from securing a fair return on the money invested in them.

Both Chicago and New York are suffering from inadequate transportation facilities, yet the average denizen of those cities is so ignorant of economics that he will vote for a mayor whose platform is a nickel fare, not realizing that by so doing he is warning every one who has saved a dollar not to invest his money in the new securities that must be sold if there is to be any enlargement, extension or improvement in the traction lines of Chicago and New York.

If ever there was a splendid opportunity for the engineers of these two great cities to perform a great public service, that opportunity now presents itself. Let the organized professional engineers investigate traction matters in Chicago and New York, and report their impartial findings to the public. Engineers are the only large body of men competent to make such an investigation, and who are at the same time sufficiently free from any suspicion of bias.

Should Depreciation Be Deducted from Original Cost?

In this issue we give an abstract of an appraisal of the traction lines in New York City. It will be seen that three different "appraisals" are given, and that one of these "appraisals" is the "original cost" less about 16.6 per cent for depreciation. This is not the first time that we have seen such an estimate of alleged "value," but the case is one of such magnitude that it seems wise to call the attention of our readers both to the economic fallacy and the immorality involved in such estimates of "depreciated value."

The reason that an old thing sells at less than its cost of replacement new is simply that the old thing will incur a greater annual expense in its operation and maintenance than will a new thing yielding equal service. This proposition has never been denied, so far as we know. If true, it follows that the cost of a substitute new thing is made the criterion by which the depreciated value of any old thing is determined.

When an appraiser deducts an estimated depreciation from the present cost of reproducing a thing new he produces a result that has real economic significance, and the result is commonly called "depreciated value." But when an appraiser deducts an estimated depreciation from an original cost he produces a result that has no economic significance whatsoever. It certainly is not "present value" and with equal certainty it is not "original cost." What is it? Shall we give it the title "depreciated cost"? If so, what does it mean? From the original cost of a thing there is deducted something because the thing is not as economic as a new thing. That is to say, a new thing is set up as a criterion, but no sooner is it set up than it is cast aside, for the cost of the new thing is ignored. The owner of the old thing is told that it has lost value because an economically better new thing is available, but when he asks that he be given credit for the enhanced value that has resulted from a rise in prices since he bought his old thing, he is met with refusal. He must suffer all depreciation, but he must not benefit from any appreciation!

It seems almost incredible that any trained engineer would ever support such an absurdity as a "depreciated original cost," first, because "there ain't no such" economic "animal," and, second, because of the unfairness to the owner of a property whose plant is thus "appraised." We might add, third, because the U. S. Supreme Court has ruled that "present value" is to be derived by deducting depreciation from present cost; but we realize that some engineers refuse to be guided by the Supreme Court even in cases that may ultimately go to that court for adjudication.

It is sometimes argued by appraisal engineers that although they do not personally approve "depreciated original cost" estimates, still they "submit them for what they are worth." Is this either ethical or logical? Would the same engineers submit a lie for what it is worth, yet refrain from calling it a lie? Should an expert witness ever testify to or report what he calls an "appraised value" something that he knows to be no such thing? We can not too strongly condemn such an act.

If there still are engineers who honestly believe that "depreciated original cost" is an "appraised value," we shall be glad to publish their arguments in favor of such a "valuation." If no such engineers exist, then it is high time that engineering societies reprimand every engineer who continues to testify to such "valuations" without at the same time denouncing those "valuations" as being the economic bastards that they are.

The Hudson River Vehicular Tunnel

Work was started April 1 on one of the largest tunnel jobs that has come up for letting in recent years. Bids on this were opened last February by the New York State Bridge & Tunnel Commission and the New Jersey Interstate Bridge & Tunnel Commission, of which Clifford M. Holland is chief engineer. The work covered the building of the under-river section of the Hudson River vehicular tunnel, included in Contracts Nos. 3 and 4, involving the construction of one river shaft on the Manhattan side of the river, two river and two land shafts on the New Jersey side, and 13,512 ft. of tunnel.

Construction will be by means of the shield method and involves the erection of approximately 115,000 tons of cast-iron segments and 5,000 tons of bolts and nuts.

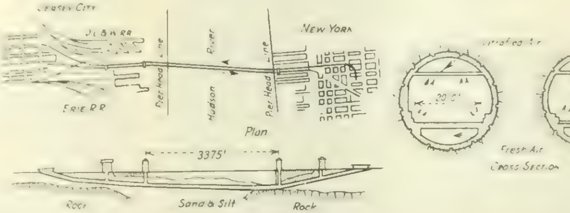
On Contract No. 3 the tunnels will begin at the Canal St. and Spring St. shafts, respectively, Borough of Manhattan, and extend in a westerly direction approximately 2,000 ft. to a point about 600 ft. west of the New York pierhead line.

On Contract No. 4 the tunnels will begin about 1,000 ft. west of the present bulkhead line in the Erie R. R. yard in Jersey City, N. J., and extend easterly to within about 600 ft. of the New York pierhead line. The land shafts will be located about 140 ft. west of the present bulkhead in the Erie R. R. yard, and the river shafts will be located about 100 ft. west of the New Jersey pierhead line as established in 1913.

The work under these contracts will include the care and support of all surface, subsurface and overhead structures, the restoration of such structures if disturbed by tunneling operations, and the maintenance of traffic.

These two contracts constitute the major portion of the tunnel project, and provision was made in each contract proposal for the submission by each bidder of two bids; that is, under Form A of Contract No. 3, a bid was made for Contract 3 only, while on Form B another bid was made contingent upon the bidder being also awarded Contract No. 4. The same arrangement applied to Contract No. 4. The plan, profile and cross section of the tunnel are shown in the accompanying illustration. The main features of the project are summarized below:

	Feet.
Length of both tunnels.	
Tube section	13,512
Cut and cover section	2,816
Shafts	320
Open approach	1,830
Total	18,478



Plan, Profile and Cross Section of Hudson River Vehicular Tunnel.

Length between portals.	
North tunnel	8,282
South tunnel	8,366
Length between grade points (total length):	
North tunnel	9,167
South tunnel	9,311
Estimated cost	$28,669,000
Estimated yearly capacity vehicles	15,800,000
Maximum depth of roadway below mean high water, ft.	93
Steepest up grade	3.5%
Steepest down grade	4.05%
Construction quantities:	
Excavation, cu. yds.	496,500
Cast iron, tons	115,000
Concrete, cu. yds.	129,400
Cement, bbls.	254,000
Ventilation data:	
Average number of air changes per hour	40
Greatest quantity of carbon monoxide permitted, 4 parts in	10,000
Total maximum quantity of fresh air per minute for both tubes, cu. ft.	3,600,000

The lowest bid received Feb. 15 was that of Booth & Flinn., Ltd., of 17 Battery Place, New York City, under Form B, and amounted to $7,199,623 for Contract No. 3, and $12,132,100 for Contract No. 4, a total of $19,331,723. The unit prices of the firm on some of the principal items were as follows:

	Contract No. 3.		Contract No. 4	
	Quantity cu. yd.	Unit price	Quantity, cu. yd.	Unit price.
Shaft excavation in earth below M. H. W.	9,200	$25.00	25,300	$20.00
Shaft excavation in rock	5,200	15.00	10	10.00
Tunnel excavation wholly in earth	61,000	25.00	246,000	15.00
Tunnel excavation partly in earth, partly in rock	14,800	42.00	9,500	47.00
Tunnel concrete not in compressed air	20,500	21.00	50,300	21.00
Shaft concrete in compressed air	650	25.00	1,770	25.00
Tunnel concrete in compressed air	820	30.00	110	30.00
	Tons.		Tons.	
Steel work, river shaft	1,800	150.00	*2,660	150.00
Special rolled section for tunnel roadway	775	70.00	1,715	70.00
Cast iron tunnel lining	33,200	53.70	72,300	47.50
Cast steel tunnel lining, except pile segments			8,950	85.00

*Land and river shafts.

Employment and Accidents in Limestone Quarries.—Reports received by the U. S. Bureau of Mines from operators of limestone quarries throughout the country show that the industry employed 43,151 men in 1920 for an average of 259 days each, or 11,154,653 shifts for all employes. These figures indicate increases as compared with 1919 of 8 per cent in the number of men employed, 12 per cent in total shifts worked, and 4 per cent in average working days per man. There was also, unfortunately, an increase in accidents, the reports showing that 96 men were killed and 5,321 were injured, or 31 more deaths and 890 more non-fatal injuries than occurred the year before. The accident rate was 2.58 killed and 143.11 injured per thousand men employed (300-day workers). The corresponding rates for the previous year were 1.97 killed and 134.05 injured.

Special Machines and Combinations for Track Work

Some interesting information on the use of mechanical appliances and tools in track work and the organization of forces involved was given in an appendix to a report presented March 15 at the annual convention of the American Railway Engineering Association by the committee on [illegible] Construction. The notes following are taken from the report.

The Plow for Spreading Ballast. The tie plow used in the unloading of ballast which has been dumped on track by center dump cars is a device made from a 8-ft. tie and old steel bars. The total cost of plow is:

Material	[illegible]
Labor	[illegible]
Total	[illegible]

In operation the plow is placed under the front of the front car with the wrought iron bars resting on the ball of the rail. Ties are placed on top of plow and wedged into position under drawbar of the car. The car is pushed with plow in front through the ballast which has been unloaded, pushing out the ballast from between the rails. This throws out all ballast to within 1 in. of the surface of the ties. The remaining ballast is then forked out from between the rails.

In most cases the plow is applied and operated by the section gang on whose section the ballast is being unloaded, although the plow can be handled by a foreman and two men. While in motion the plow is watched and signals passed to enginemen on work train.

With a gang of foreman and nine men, four cars of rock ballast were unloaded and spread in 20 minutes, 10 minutes being used in each operation or at a cost under present scale of wages of $.0077 per cubic yard for unloading and $.0077 for spreading. By using this type of plow, from 75 per cent to 80 per cent of the ballast is plowed out from between the rails; the remainder must be cleaned out by hand.

Snow Flanger Used for Ballast Plow. After ballast has been dumped on track by center dump cars and leveled to the top of rail by using tie in front of rear truck of ballast car it can be thrown from between the rails by use of snow flanger. The snow flanger consists of a box car with two plows hung between the trucks in such a manner that one plow will operate in each direction. The plow is pushed by the rear truck and suspended from the body of the car in such a manner as to permit it to be raised or lowered by air. The lowest position of plow is 5 in. below top of rail and highest position 4 in. above top of rail. In using snow flanger as ballast plow the blades of plow should be strengthened by application of heavier plates.

In operation the flanger which is carried in the ballast train is pushed over the track through the ballast which has been dumped, leveling the ballast to approximately one inch above the top of ties. The ballast remaining between the rails is then cleaned out to proper depth by hand. Approximately 75 per cent of the ballast is taken out by the flanger; the remaining 25 per cent must be removed by hand.

The organization used in handling of flanger consists of work train crew, one man to operate levers, raise and lower plow, and one man to watch plow and signal operator and engineman. The work of leveling by flanger of four cars of ballast requires approximately 10 minutes.

The use of snow flanger as ballast spreader appears to be no more efficient than the use of tie plow and unless equipment is standing idle should not be considered on account of the expense involved in the equipment.

Lidgerwood Unloader for Unloading Trainload of Gravel Ballast in Side Door Cars. This apparatus consists of a plow of slightly less width than the inside width of the cars, a cable which can be purchased in lengths for 10, 20, 30, 40, etc., car lengths, and the Lidgerwood. This latter is a power driven drum upon which the cable is wound.

In operation the cable is stretched over the cars from the Lidgerwood to the plow, the plow being placed at the rear of the train. The cable is usually stretched by hand, although where a number of trains are to be unloaded a boom is rigged to assist in stretching cable. The train is then run to location at which gravel is to be unloaded. The doors are opened and with the train in motion, the Lidgerwood drum reels in the cable pulling the plow through the cars pushing off the gravel. The plow is left standing in the ballast car next to the Lidgerwood. The doors of cars should be closed before leaving the [illegible].

The organization used is work train and crew, one foreman and 10 to 14 laborers, depending on the length of cable to be used. While Lidgerwood is in operation one man passes signals to operator of Lidgerwood and to engineman to control the amount of ballast unloaded. The plow is followed through the train by the gang, which cleans up cars and prepares to close doors.

In a recent test of cost of unloading 40 cars of gravel from Haskell Barker cars 1 foreman and 14 men performed as follows:

Stretch cable	[illegible]	[illegible]
Open doors	[illegible]	[illegible]
Plow off ballast	[illegible]	[illegible]
Close doors	[illegible]	[illegible]
Total	[illegible]	[illegible]

Rate of foreman $.54 per hour, labor $.39½ per hour. Total cost $13.66. Total cu. yd. 1,200. Cost per cu. yd. $0.0114.

Pneumatic Tie Tampers. There is no part of track maintenance which has required more labor in the past than that of surfacing of track. The production of mechanical means of tamping of ties has been the aim of a number of manufacturers.

In the last seven years considerable progress has been made in the development of pneumatic tampers. The results obtained by tests run on efficiency of these machines have proved their economy over the old method of hand tamping.

The experience of the roads who have used this machine considerably indicates that the machines are a success and that it is a matter of education and organization to secure favorable results. There appear to be three factors which should be considered for their successful operation:

(a) Mechanic familiar with a machine to supervise its operation and to educate the section foreman and machine operator.

(b) Foreman and laborers should be educated as to the proper method of tamping and as to the time that each tie should be tamped.

(c) A general overhauling of the machines at the end of the seasons so as to have them in first class condition for the following season. This to eliminate repairs, barring accident, during the season of surfacing.

In order to secure the full efficiency of the machines it is desirable that some type of report be furnished daily by the foreman operating the machine. This report should in general show the hours worked, the cost of the gang, ties tamped, quantity and cost of oil, gasoline and grease, character of work, loss of time and cost of repairs. From this information, data can be accumulated by the division engineer's office which can be used in increasing the efficiency of the machine if they have fallen below the standard for that type of machine.

The results which have been obtained by several of the railroads who have used the pneumatic tampers for several years justify more extensive use of tampers. The following statement shows the cost in money per tie tamped which was secured by tests on the D. L. & W., B. & O. and I. C.

	Cost per tie tamped	
D. L. & W.	$0.113	8 weeks' special test
D. L. & W.	0.1[illegible]	1 machine season
B. & O.	0.[illegible]	[illegible]
I. C.	0.0[illegible]	4 weeks' special test
L. V.	0.13	

All rock ballast. The variation in rate per hour paid the laborer will explain most of the variation in figures on the Illinois Central and Delaware, Lackawanna & Western.

In the handling of four tamper outfit the following organization is usually used:

Foreman
Operator of compressor
Four laborers operating tampers

The foreman's time is divided between the tamping machine and the supervision of the remainder of the gang who are used in throwing ballast, dressing and spacing of ties. The operator is usually one of the men of the gang who spends a small portion of his time in care of the machine, this being approximately 1 hour 30 minutes per 8-hr. day, remainder of his time is spent with the gang, in dressing. The four laborers tamping usually work 6 hours in the 8 hour period, the remainder of the time is spent working with the gang, in lining and finishing of surface.

The following figures relate to work done with pneumatic tampers operated by 4-cycle 30 H P [illegible] compressor in July, 1921, near Scottsville, W. of Meshoppen, Pa.

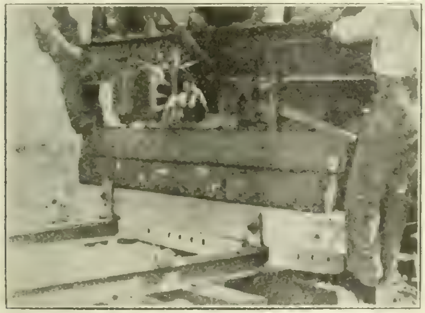
Force 1 Foreman.
8 Laborers, operate 8 [illegible]
2 Laborers, shovel in b[illegible]
1 Laborer operates [illegible]
Total 1 Foreman, 11 men.
Raised and tamped 3,000 ft. track
Compressor worked 21 days. Idle 4 Sat[illegible]
2 days [illegible]
2 days [illegible] laying rail.

Cost		
Labor	$645.87	
Oil and gas	84.1[illegible]	[illegible]
Maintenance	[illegible]	
Total	$73[illegible]	[illegible] per lin. ft.

Track Mowers. These machines are successful as long as the operator understands that they must be regulated according to the kind of weeds to be cut. The experience of the different roads with these machines has varied considerably and it is not possible to give a definite opinion as to their operation.

One railroad has found that it is hard to keep the speed down and therefore had discarded gasoline and substituted a mule. They now haul their track mowers along by horse power or mule power at 2½ miles per hour and get along very nicely.

Another road has found that if it is run at a high rate of speed, four miles per hour, it will cut the tougher stuff such as heavy sweet clover and hemp and that it takes a high speed to accomplish any results with this tough stuff but at the same time going at a high speed it will not cut quack grass or the ordinary grasses. This road is in favor of using two lengths of cutter bar, one to get the grass far out and another to trim up close in. Also they have adopted a wrinkle which, while it may not be new, is ingenious in saving. They take out two of the bolts and substitute wooden pins for them and then when the cutter bar accidentally hits an old rail rest or a rail itself the pins will break out and the bar be saved.



Tie Plow in Place with Cross Ties and Wedge.

One machine will cover about ten times as much as a man.

Bonding Machines.—There are several styles of pneumatic bonding machines, any one of which will do about twice as much work as hand labor.

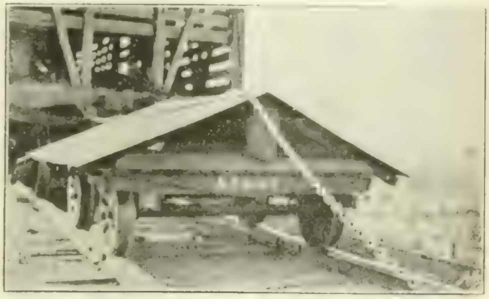
The M. K. & T. Railway have developed an electric bonding machine which was used on some recent signal construction work. The machine, which consists of a storage battery and two drill frames, is supported and carried on a light safety first type motor car. The battery, which is assembled in two trays with slip electrical connections, is carried on each side of the car, while the two drill frames are suspended ahead of the car on a light steel framework, all of which is easily disconnected, and removed from the car. Each drill frame carries two Black & Decker 32-volt electric drills which are operated in multiple and so arranged that two holes required for each wire are drilled simultaneously. Each frame weighs 115 lb., while each tray of the battery weighs approximately 150 lb. The drills are high speed and high speed steel bits are used with the results that it requires only thirty seconds actual drilling time to drill a joint, so that in actual work one signal man and two helpers have accomplished practically the same amount of drilling and bonding in a day that was formerly done by a foreman and six men with hand machines.

COST OF BONDING TRACK BY HAND DRILLING

1 Foreman		$ [illegible]
6 Helpers	at $ [illegible]	[illegible]
640 Bond wires	at [illegible]	[illegible]
640 Channel pins	at [illegible] M	[illegible]
6 Drill bits broken	at [illegible]	[illegible]
1 Drill bit worn out	at [illegible]	[illegible]
Total cost per mile (320 joints)		[illegible]
Cost per rail joint		.113

COST OF BONDING TRACK WITH ELECTRIC POWER DRILL

1 Foreman		$ 7.20
2 Helpers	at $ [illegible]	[illegible]
600 Bond wires	at [illegible]	[illegible]
600 Channel pins	at 15.00 M	[illegible]
1 Drill bit worn out	at .60	.60
2 Gallons gasoline	at .20	.40
½ Gallon oil	at 1.00 ga.	.50
Total cost per 300 joints		$41.30
Cost per joint		.1443
Total cost per mile (320 joints)		46.18



Push Car with Sloping Iron Protection for Unloading Rail from Stock Cars.

Handling Rail with Air Unloader.—The machine in general use for handling rail in and out of cars. It consists of an "A" frame with boom, and is placed on a standard flat car. An air piston with a 5-ft. stroke furnishes the power and the cable is wound so that a 15-ft. lift is obtained. A work train is necessary and air for the cylinder is taken from the train line. The boom is swung by ropes, leading from the end of the boom to the ground.

The following organization is generally used:

Loading and unloading.
1 Foreman.
1 Machine operator.
1 Tongman in car
1 Tongman on ground
1 Railman in car guiding rail
1 Railman on ground guiding rail
2 Ropemen, one working on each side to [illegible]

This machine requires no engineer, nor fireman, as on a steam ditcher, locomotive crane or derrick car. It is always carried on the work train and used for loading and unloading of miscellaneous materials as well as rail.

Unloading Rail from Stock Cars, Two Rails at a Time Falling Onto Push Car.

In congested territory, two air loaders are installed on one flat car, one on each end, with the same organization for each as outlined above, except that only one foreman is used. The advantages of this method are in speeding up the work and the use of only one work train.

Rail Laying with Locomotive Crane.—The Lehigh Valley R. R. used two locomotive cranes in relaying 136-lb. rail on main track during June, 1921. The track was abandoned during the operation and all traffic was handled over the other track, using a work train engine as pilot. Each crane handled the rail on one side only, and the following organization was used on each:

	North Rail Locomotive Crane No. [illegible] Foreman	Men	South Rail Loco. Crane No. [illegible] Foreman	Men
Pulling [illegible]		8		30
[illegible]		10	[illegible]	8
[illegible]	1	[illegible]	1	8
[illegible]	1	4	1	[illegible]
[illegible]	1	[illegible]	1	10
[illegible]	[illegible]	[illegible]	4	36
[illegible]	[illegible]	16	1	15
[illegible]	4	[illegible]	4	40
[illegible]	1	[illegible]	1	[illegible]
[illegible]	1	[illegible]	—	[illegible]
[illegible]	—	1	—	1
[illegible]	—	1	—	1
Total	10	166	17	172
First rail laid	8:[illegible] a. m.		7:12 a. m.	
Last rail laid	[illegible] p. m.		3:17 p. m.	
Total number of [illegible] rails laid	[illegible]		617	
Track closed fully bolted and spiked....	5:30 p. m.		5:00 p. m.	

Bonding organization using one tie tamper with 8 pneumatic drilling machines

2 Gas engine men.
8 Signalmen handling drills.
4 Men bonding.
2 Men sharpening drills.
2 Men distributing material.
3 Men [illegible] wires.

Madden Track Laying Machine.—This machine consists of a light steel frame with a crab and fixed boom, which rests on one running rail and a small auxiliary rail which is carried with it, the gauge of the machinery being somewhat less than standard. The normal speed of the machine on 130-lb. rail is about one rail per minute, or a trifle faster. The organization with various sized gauge is shown below:

	Men
[illegible]	8
[illegible] rail	4
[illegible]	7
[illegible]	1
Madden rail layer—	
[illegible]	1
[illegible]	2
[illegible]	4
[illegible]	
[illegible]	4
[illegible]	9
[illegible]	11
[illegible]	2
Total	53

Rail Unloader, for Unloading Rail from Stock Cars.—As the movement of stock cars west is an empty movement it is often desirable to use these otherwise empties to haul rail westward. Therefore, a special arrangement has to be made to unload rail from stock cars. There is a machine for this purpose. In connection with it a push car is necessary with a sloping protection of iron over it. This is formed by three bent rails and a covering of ⅜ scrap boiler plate.

The covered push car which receives the rails is chained to the car loaded with rails by a chain 15 ft. in length, depending on the length of rails to be unloaded.

Ballast Cleaning Machines.—The committee has considered four mechanical devices for cleaning ballast, embodying ballast screens on which the ballast is thrown by hand, and a mechanical ballast cleaner which travels in an inter track space, and uses an endless chain of buckets which lifts the ballast and after cleaning returns it to the ditch; a rotary screen into which the ballast is thrown by hand; and the use of a ditcher and clam shell bucket by which it is hoisted onto a sloping screen, letting the dirt go into a car and the ballast back onto the track.

Pratt Mechanical Ballast Cleaner.—This machine travels in the center ditch resting on the ends of the ties, and is designed to clean the ballast in the center ditch only. An endless chain of buckets lifts the dirty ballast and throws it on a shaking screen. The clean stone rolls over the screen and returns to the center ditch while the dirt goes through the screen onto a pan, and is shoveled out by hand. The machine is driven by gasoline engine and will clear the traffic on both the adjoining tracks.

The designer of this ballast cleaner had in mind a small unit which would operate independent of passing trains, and would separate the stone from the dirt mechanically.

The organization used is as follows:

One man [illegible]
[illegible]
[illegible]
Two men shoveling out dirt.
Two men helping the ballast into the buckets and loosening ballast ahead of the machine if very hard.
One man watching for trains, where traffic conditions require it.

Ballast Cleaning with Ditcher, with Clam Shell Bucket and Ballast Screen Mounted on Gondola Car.—This operation consists of lifting the ballast from the center ditch with a clam shell bucket and dropping it on a sloping screen mounted on a gondola car. The dirt goes through the screen into the car and the stone passes over the screen and through a chute back to the inter track space. The clam shell digs the ballast to a depth of about 10 in. below the bottom of tie and from end of tie to end of tie, but does not reach any of the ballast in the cribs.

This outfit will clean at the rate of one rail length in seven minutes. The cost of the train, including crew and laborers, is about $100 per day. The economy of the operation will depend on the ability to get the use of track.

The organization is as follows:

Train crew, including:
Engineman.
Fireman.
Conductor.
2 Brakemen.
Ditcher operator.
Ditcher fireman.
3 Laborers: one laborer levels dirt in the car, another attends to the bucket and knocks down ballast at tie ends, and another levels the cleaned ballast in the center ditch.

Tree Growth Under Prairie Conditions.

The following measurements secured in 1920 are given in the report for the fiscal year ended March 31, 1921, of the Director of Forestry of the Canadian Department of Interior as an indication of the growth under prairie conditions where trees are spaced approximately 4 by 4 ft.:

Plot No. 1.—Native tamarack planted in 1904; present average height, 24½ ft.; maximum height, 29 ft. 9 in.; average diameter, 3½ in.; maximum diameter, 4¾ in.

Plot No. 5.—Scotch pine planted in 1906; present average height, 19 ft. 9 in.; maximum height, 22 ft. 10 in.; average diameter, 3¼ in.; maximum diameter, 5 in.

Plot No. 7.—Cottonwood and maple in alternate rows, planted in 1906. Average height, cottonwood, 30 ft. 9 in.; maple, 20 ft. 2 in. Maximum height, cottonwood, 36 ft. 6 in.; maple, 28 ft. Average diameter, cottonwood, 4½ in.; maple, 2¾ in. Maximum diameter, cottonwood, 6¼ in.; maple, 4⅓ in.

Plot No. 8.—White birch and maple in alternate rows, planted in 1906; birch, average height, 23 ft. 2 in.; maximum height, 29 ft. 6 in.; average diameter, 3¼ in.; maximum diameter, 4½ in.

In view of the prevailing idea that conifers (evergreens) are so much slower growing than the broad-leaved kinds, it is interesting to notice that the maples in Plot 7 on the average show only about 4 in. more height-growth than the Scotch pine in Plot No. 5 and average ¾ in. less in diameter. It is safe to say that the pines in Plot 5 would yield at the present time considerably more wood material than the maples in Plot 7, planted at the same time and under exactly the same conditions of soil and spacing.

March Largest Construction Month in Two Years.—The month of March witnessed the largest volume of construction started in any month since April, 1920, according to the F. W. Dodge Co. The total amount of contracts awarded during March in the 27 Northeastern States of the country amounted to $293,636,000, an increase of 65 per cent over February and of 79 per cent over March, 1921. The first quarter of this year was 68 per cent ahead of the first quarter of 1921. Practically every class of construction showed a notable increase in March. The amount of residential construction was the largest since the summer months of 1919. March residential contracts amounted to $121,551,000, which was 40 per cent of the month's total. Public works and utilities amounted to $51,997,000, or 18 per cent of the total; business buildings, $49,758,000 (largest figure in this class since May, 1920), or 17 per cent of the month's total; educational buildings, $25,575,000, or 8 per cent, and industrial buildings, $24,270,000, or 8 per cent. The amount of contemplated new work reported in March was $613,000,000, more than double the amount of contracts awarded, the largest amount of contemplated work reported for any month since March, 1920.

Use of Explosives in Production of Crushed Stone

Selection and Methods of Using Explosives in Quarrying, Described in Paper Presented Jan. 17, at Convention of National Crushed Stone Association

BY S. R. RUSSELL,
Technical Representative, E. I. du Pont de Nemours & Co.

It is estimated that more than 60,000,000 of high explosives were used in quarry and open pit operations in the United States during the year 1920. A conservative estimate of the value of these explosives would be $10,000,000. If to this is added the cost of black blasting powder—of which a considerable quantity is used in the stone industry—and the cost of blasting accessories, it would perhaps be no exaggeration to say that quarrymen paid more than $12,000,000 dollars for explosives alone during that year. The importance of the subject of explosives in quarrying is therefore obvious.

There was a time when little or no attention was paid by quarrymen to the question of explosives but this is happily not the general rule today. Almost all the important and successful operators are now giving the matter of explosives serious consideration and study. And it is well they should do so, because the manner of blasting affects every subsequent operation in the quarry, loading, conveying and crushing. If the drilling and blasting are not properly done—and these two operations should be considered together, for it is not possible to blast efficiently if the drilling has not been properly done—the result will be a low shovel or loading efficiency, high secondary blasting cost, reduced output through the crusher, and a final high cost per ton of stone. The blasting, therefore, is the heart of the whole quarry system and the selection and method of using explosives are vital matters.

Qualities to Be Considered in Selecting Explosive.—Some of the most important qualities to be considered in selecting an explosive for quarry use are—strength, sensitiveness, stability, velocity or rate of detonation, ability to resist water and density. Upon the proper combination of these various characteristics as revealed by actual shooting depends the adaptability of an explosive to the work at hand.

Strength, of course, is of prime importance but a low strength explosive is often better adapted to and will give more satisfactory results in some classes of work than one of high strength. Almost any strength is obtainable. The straight and ammonia types of dynamites may be had in all strengths from 15 per cent up to 60 per cent. When it is necessary to use a higher strength than 60 per cent, gelatine dynamite must be used and it is manufactured in all strengths from 25 per cent to 100 per cent.

The degree of sensitiveness of an explosive is also of great consequence, for it is essential that an explosive be sensitive enough so that full detonation and maximum efficiency can be gotten out of it by the standard detonator, yet it must not be so sensitive that it becomes dangerous when subjected to ordinary handling in use and transportation. Safety is a prime consideration, and the balance in this matter of sensitiveness between efficiency and safety is one of the features which makes necessary expert knowledge and skill in the manufacture of explosives.

Stability or the quality of remaining fixed or uniform is highly important. No one wants an explosive that is liable to go off spontaneously during storage, or which becomes more, or less, sensitive with age, or is affected by ordinary changes in temperature.

The velocity of detonation or speed with which an explosive develops its maximum pressure must also be considered. This quality varies greatly with different explosives. Where great shattering is desired an explosive with a high rate of detonation should be used, but where a heaving or rending action is required, a slower one is better adapted.

Some explosives will not resist water for any length of time, while others are almost unaffected by water. Some are light and bulky while others are heavy and dense. All these factors must be taken account of when deciding the explosive best adapted for a piece of work.

There are, of course, other important requisites for a well balanced explosive which must be considered by the manufacturer in order to produce a uniform, reliable and efficient blasting agent. The manufacture of explosives is indeed a highly scientific business, involving the maintenance of many trained chemists and engineers to assure such purity of raw materials, balance of ingredients in the formula, and exactness in plant processes as will produce explosives which will meet the widely different conditions found in actual work, and will be uniform, stable and safe. It can be said without boasting that American explosives manufacturers are today turning out a wonderfully efficient product.

Determining Proper Explosive for a Particular Case.—It is sometimes quite a problem for the quarryman to determine the most economical and efficient explosive to adopt. Conditions vary so much in actual practice and there are so many different explosives made, each having its own peculiar characteristics, that it often requires considerable experimenting to arrive at the one best suited for the work. We, as explosives men, with a wider experience in their use than any one operator can easily have, are always willing to co-operate and to assist the consumer to the best of our ability in selecting both the most economical and efficient explosive for his work.

Many things must be considered in determining the proper explosive to employ. Among them may be mentioned the kind of quarry, whether pit, side hill or cliff; the nature of the material, whether it be hard or soft, tough or brittle, limestone or trap; the direction of the strata; the thickness of the ledges; the height of the face or the benches; the method of drilling; the method of loading; the size of the crusher; purpose for which the stone is used; and whether the work is wet or dry. The system of drilling, the method of handling the stone and the selection of the explosive are more or less interdependent and are in turn governed or influenced to a great extent by the height of the face, hardness and stratification of the stone, size of the crusher, and output desired. Each quarry presents its own problems, however. No hard and fast rules can be laid down to cover all operations although in quarries of the same class, similar methods and explosives can usually be recommended.

Kinds of Explosives.—The explosives generally used in quarries in this country are straight nitroglycerin dynamites, extra or ammonia dynamites, gelatine dynamites, nitrostarch powders and, to a lesser extent, the comparatively recent type of explosives which are very light and bulky and are marketed under various trade names. Straight dynamite is the original high explosive and is the standard against which all other explosives are measured. Straight dynamites are still generally considered the quickest and most shattering, although it is now understood that gelatin dynamites, when confined, are just as quick as and sometimes quicker than the corresponding grades of straight nitroglycerin dynamite. Gelatin dynamites are also the densest and heaviest commercial explosive and will resist water indefinitely, standing first in this respect. Gelatin dynamites, unless under confinement, are relatively slow in action and should not be used for such work as mudcapping. The extra or ammonia dynamites are made by combining nitroglycerin, nitrate of ammonia and other explosive ingredients. They are slower in action than the corresponding grades of straight dynamite and will not resist water so well, but they have many desirable characteristics which make them well suited for general use in quarry work. They are as a rule cheaper and safer to handle than other kinds. More ammonia dynamite is used in all classes of work than all other kinds put together. The nitrostarch explosives, as their name implies, consist of nitrated starch mixed with nitrate of soda and nitrate of ammonia. They contain no nitroglycerin. They are slower, more hygroscopic, and less sensitive than the nitroglycerin compounds. Judson or R. R. P. powder should also be mentioned. This is a crude black powder, the grains of which are coated with nitroglycerin. It is well suited in tunnel or gopher hole blasting in quarries, in sprung holes for removing lighter materials, or where something stronger and quicker than black powder is desired. It is not suited to wet work.

Cost Per Ton of Stone Produced Basis for Figuring Blasting Cost.—In figuring blasting cost too much stress is generally laid upon the cost per pound of explosive rather than upon the cost per ton or yard of rock. The only way of arriving at a true cost and a true measure of the efficiency **of the explosive, is by calculating the number of tons pro**duced per pound and by taking into consideration the shape in which the stone is produced and the other significant factors in the operation. Almost anyone can go into a quarry and reduce the explosive cost per ton. Either by using a cheaper priced or a lower grade explosive, or by arbitrarily cutting down the loads per hole one may move just as many tons of stone per pound. Note, however, that I say move; **whereas successful and economical blasting does not mean** merely moving or throwing down so many tons of stone. **It means throwing down the material in proper condition,** consistent with the equipment for handling and the purpose for which it is to be used and with due regard for the after costs, such as those of secondary blasting, loading, track movements and crushing. A lowering in the shovel efficiency on account of difficult digging caused by poor blasting, with consequent increase in shovel repairs, will far outweigh in cost any slight decrease in explosives cost per ton of stone. It has often been found that the use of a higher **strength or different kind or greater quantity of explosive** in the primary blast has resulted in a lower ultimate cost per ton.

What I wish to emphasize here is the fact that it is not the price per pound of the explosive that is so important, but the cost per ton or yard of stone produced, not even the explosive cost per yard of the material as blasted but the final cost on the cars, which includes drilling, blasting, load**ing, transportation, crushing, overhead and all other operat**ing expenses. Blasting affects every item in the cost analysis and if it is not properly done, the cost of each subsequent operation will be higher than it should be.

How Proper Explosive Increased Quarry Output. Let me **cite an actual case which is typical of many. We were called** upon by a large concern to visit one of their quarries where for some years they had been getting rather poor results. The costs were high and the output not commensurate with the capacity of the plant and equipment in use. They were using well drills and drilling 40 ft. to 45 ft. holes, $5\frac{5}{8}$ in. diameter. Many of the holes were very wet, a 40 ft. hole sometimes containing 20 ft. of water. They were using a dynamite not at all suited to wet conditions. The cartridges were 4 in. in diameter. The blaster naturally was afraid to **break the cartridges and expose the dynamite directly to the** water and consequently they were loaded intact one on the other. The result was that the explosive could not be concentrated in the bore hole. The steam shovels, three of them, were working on an average between 40 per cent and 50 per cent capacity. It was not uncommon for a shovel to be held **up four or five hours on account of drilling and blasting bot**tom. The drilling was rather carelessly done and the spac**ing for 45 ft. holes was 6 ft. apart and 12 feet back, which** is very close spacing for limestone. We changed over to gelatin dynamite, increased the size of the cartridges to $4\frac{1}{2}$ **in. in diameter, reduced the gauge of the drill bit to $5\frac{1}{4}$ in.** and made certain that all holes were drilled 5 ft. below the grade. As a result, after two years' trial, there is rarely any **trouble with bottom, the shovel efficiency has jumped to 70 per cent, and two shovels are handling what it formerly re**quired three to do. The spacing of holes has been widened to **8 ft. apart and 15 ft. back. The quarry is in better shape,** the output greater, and the cost per ton less, and this in spite of the fact that the explosive now in use costs more per **pound than the one formerly employed.**

Some Points on Drilling.—In this particular instance, the drilling also was at fault and the explosive in use was too light and otherwise unsuited for the work. The density of an explosive is very important in some quarries. If the bottom is hard or irregular, and there is no distinct parting at the floor of the quarry, it is absolutely necessary to concentrate the explosive charge at that point. This can be accomplished by completely filling the borehole or by using an explosive of high density, or by drilling a sufficient depth below the floor grade. If there is much water present it is almost impossible to pack the granular type of dynamite, **hence a gelatin dynamite, which is unaffected by water, in** cartridges with a diameter nearly as large as the hole, is required.

The drilling should not be left to guesswork or judgment of the driller. **To my mind, this matter of drilling to proper** depth is of the greatest importance in a quarry. Holes are not generally drilled deep enough below grade. In order to be sure of the proper depths it is advisable to run a line of levels over the floor and on top of the quarry face, establishing permanent bench marks and setting reference stakes at various stations around the face for the drill man. These stakes should indicate the depth to which the holes should be drilled. This little item alone may be worth a great many dollars to the quarryman in a season.

I do not intend to discuss at this time the merits of the different types of drills for quarry use. Much has been written on this subject heretofore. The blast hole drill or well drill is now widely employed and its advantages are pretty well established in quarries where the conditions are favorable for its use. Still there are many quarries where the tripod type of drill is still in favor and where it is the most economical to use.

Suggestions for Loading Well Drill Holes. So much has been written and published in regard to the procedure in loading well drill holes that it is perhaps unnecessary to dwell on this subject extensively. A few remarks may be in **order, however.**

The use of large diameter cartridges is advisable in loading deep well holes and manufacturers can furnish dynamite in all sizes up to 5 in. in diameter. Large cartridges lighten the labor of loading and permit a higher concentration or greater bore hole density of the explosive in the bore hole. When large cartridges are used, very little tamping of the explosive, and often none at all, is necessary. Tamping here does not mean stemming. If holes are dry the cartridges should be slit lengthwise two or three times and dropped or lowered into the hole. The fall causes the powder to spill **out, practically filling the hole. Slitting the cartridges is** not advisable when water is present. Make haste slowly in **loading explosives in quarries, especially in large holes. Do** not hurry the work but furnish enough help on the job so that loading will go on with despatch. Such despatch may often result in saving money, especially if the holes are wet, and besides it means disposing of a rather unpleasant and anxious job quickly. From four to six tons of stone is, as **a general rule, considered good for primary shooting in well drill work. If the bottom is heavy or if there is a hard toe,** it is best to use a higher strength **explosive at that point,** loading the upper part of the hole with lower grade.

Do not load holes when too near a steam shovel or locomo**tive, unless a screen or awning is used to prevent sparks or** hot cinders from falling into the hole. There have been **some very disastrous accidents from this cause alone in the last year or two.**

Points on Well Drill Work.—In well drill work the holes **are usually drilled and blasted in single rows. The question often arises whether it is better to blast two or three rows** at a time, the holes arranged in staggered order, or one **row. Some experienced men think that better results and greater fragmentation are obtained by blasting two rows at** a time. Most quarries, however, use the single row system. I am inclined to believe that the single row is best when the **face of stone is 50 ft. high or over. Below that height, it** depends upon local conditions. The general practice with relatively shallow holes, from 20 ft. to 30 ft. in depth, is to **blast from two to five rows at a time in order to break the** stone up well and in greater volume so that the track and **shovel movements are kept at a minimum. When more than** one row is carried, the holes in the back row should be loaded at least 10 per cent heavier than those in the front for best results. I believe also, that the spacing between rows should be less than the distance from the first row to the edge of the face. In high faces, I do not think the double **row advisable at all. Often, even in quarries where the** face is 50 ft. or under, only one row is blasted at a time, but a buffer or blanket of stone is carried, that is, a whole or part of a shovel cut from the previous blast left against the face to be shot. The idea of the buffer is that it offers greater resistance or confinement to the charge and better fragmentation is gained. It is used in many cases, especially in lower faces, to hold back the material so that the stone is piled up high enough for economical working of a steam shovel and to avoid irregular track and frequent moving of track. I believe in a buffer in the lower faces, especially if a shovel is used for loading. Sometimes, however, too much buffer is used and the stone is not thrown out far enough to permit access for the secondary drilling and blasting. The shovel is consequently often held up until the obstruction is drilled and blasted. It is often better, especially if the stone lies in heavy ledges and there are open seams, and the tendency is for the ledges to move or slide before the full breaking effect of the explosive is gotten, to allow the material to be thrown farther out so that secondary treatment can be carried on before the shovel reaches that point. In higher faces, from 50 ft. to 200 ft., no ladder whatever is used nor is it necessary. Each blast is cleaned up before another is thrown down.

There are many quarries where the tripod method of drilling is the most economical. This is apt to be true especially in quarries of low face where the full depth can be carried in one bench. It is a method well suited to quarries where the stratification is irregular or pitching heavily, and where it is impossible to maintain regular benches.

Snake Hole Method. In many of the harder limestone, trap and granite quarries, very economical results are obtained by what is known as the snake hole method. Often a face of rock 50 ft. to 60 ft. high can be brought down with a single row of bottom holes which are heavily sprung. This method is commonly used in many of our eastern quarries. The holes are drilled horizontally at the bottom of the face of the rock from 20 ft. to 30 ft. in depth and sprung heavily. It is best to start the hole about 3 ft. above the floor allowing it to dip so that at the point it is just above or at the level of the floor. It is unwise to start the hole too low. A certain dip must be maintained in order to allow water flow to the drilling surface. Therefore, if the hole is started too low, its point may be several feet below the floor level before springing, and this depth is increased considerably after springing.

Springing Bore Holes.—It requires considerable judgment on the part of the blaster to spring holes successfully. After some experience he soon gets so familiar with the ground that he is able to tell quite accurately how often he must spring, and how heavily, in order to accommodate sufficient pocket charge to lift the burden. Some rocks respond to springing much better than others. Holes are usually spaced about 8 ft. apart. A strong quick explosive is best suited for springing holes. The first charge should consist of not more than three cartridges of 1¼ in. x 8 in. dynamite. If there is drill muck or water in the hole this charge will not do much more than clean out the hole and will have a very slight heating effect on the walls of the hole. If the hole is dry, this charge will enlarge it somewhat at the back and heat the walls. In the first case when hole is wet, it is unnecessary to wait longer than one-half hour before loading the second charge. If the hole is dry, it is advisable to wait one hour. The second charge should consist of, say, six cartridges and after firing, 1½ hours should be allowed to elapse before loading the third springing charge. Each subsequent springing charge is increased so that the chamber or pocket made by the preceding one is filled, or perhaps it is best to let the explosive rise a few inches more each time until the necessary size chamber is obtained. Compressed air may be blown into the hole after springing. The air, besides blowing out a great deal of pulverized rock, hastens the cooling of the hole, making work safer and quicker.

Many accidents have been caused by loading the final charge of explosive in the bore holes too soon after springing, the charge taking fire from the heat of the hole. It is, therefore, good policy to wait long enough and to be sure that the hole is cool. A rough idea of the temperature can be gained by allowing the tamping stick to stand in the hole about five minutes and then feeling the end of the stick with the hand to find out whether it has become warm. To be absolutely sure, the intervals between charges should be regulated as follows:

After the first spring wait one hour.
After the second spring wait two hours.
After the third spring wait three hours.
After the fourth spring wait four hours.
After the fifth spring wait five hours.

It is seldom necessary to spring more than five times. I would advise waiting after the last springing is done until the following day before loading the holes.

As said before, a strong, quick explosive like 50 per cent or 60 per cent Straight N. G. is best for springing in hard rock. For loading the chamber an explosive of lower strength and slower action is best.

Secondary Drilling.—For a secondary drilling, rotating hammer drills are most satisfactory and are now generally used. It is good practice to drill the large stone rather than to resort to adobe blasting, or mud capping. It requires about 20 per cent as much dynamite loaded in a block hole to break a stone as it would require to "doby" it. Moreover, an explosive of lower strength than is used for primary shooting can be used for block hole work. Whereas, a strong, quick explosive is required for mud capping, a 20 per cent or 30 per cent ammonia dynamite is advised for block holes in the dolomites or hard limestones and nothing higher than 40 per cent for traps or granites.

Mud capping should not be allowed except in emergency, for it is very wasteful. When mud capping is practiced the cost of secondary blasting averages about four tons per pound of explosive, while block hole work the cost runs from 15 to 18 tons per pound of explosive.

Only the best blasting accessories should be used in connection with explosives. Great care should be exercised in testing electric blasting caps and in making connections, the joints being made tight, clean and dry. Only series connections can be made when blasting machines are used as a source of current, because these machines are designed only for series firing, having a low amperage—about 1½—and a voltage sufficient to fire their rated capacity.

Firing the Blast.—It is best to fire big blasts with a power or lighting circuit. Either direct or alternating current of 25 cycles or over will do. It requires 1½ amperes to fire any number of electric blasting caps in series, but this strength of current must be maintained all along the circuit. Therefore, the greater the number of caps in series, the higher the voltage or pressure necessary to hold the current up: 1½ amperes and a voltage equivalent to 1½ times the number of caps in the series should be supplied. It is better, however, when power is used for firing, to connect electric detonators in parallel or parallel series. When straight parallel is used, which I like best, in well drill work with electric blasting caps, ½ ampere should be provided for each cap in the circuit. In this case a high amperage but a low voltage is required. In parallel series, at least 1½, and better 2, amperes should be provided for each series.

In priming deep well drill holes, it is advisable to use sufficient detonators distributed along the charge both to assure thorough detonation and to afford a way out in case one should be broken during loading. At least two caps should be loaded in any bore hole, for assurance. Missed holes are expensive and often fraught with danger and no effort should be spared to prevent their occurrence. If proper care is used in making connections and rules and instructions are carried out, there should be much less trouble from this source than unfortunately exists now in many quarries.

Cordeau-Bickford or detonating fuse is coming into general use for firing large blasts. Cordeau is especially well adapted for well drill hole blasts and is a very safe, sure and efficient detonator. It is besides very easy to manipulate. Cordeau consists of a lead tube about .22 in. in diameter, filled with T. N. T. It has a rate of detonation of about 18,000 ft. per second and is therefore of great value as a detonator in quickening slow explosives and assuring complete detonation of explosives of low sensitiveness. It is unnecessary at this time to explain its use as explosives manufacturers will furnish on request descriptive booklets showing how to manipulate this material.

The storage of explosives is very important but this matter is often sorely neglected. They should be stored in dry, well-ventilated magazines. Brick is the safest material to use in construction. The walls of a magazine should be thick enough to be bulletproof. Cases of high explosives should be used stacked in proper position and the oldest dynamite should be first. Blasting accessories such as electric blasting caps and blasting caps should be stored in a separate building which should be cool and dry.

The Blasting Superintendent.—It is interesting to note that quarry operators are giving more attention to the subject of explosives. Many of the larger companies have in their employ a blasting superintendent who devotes all his time to a study of the blasting methods, and results obtained, and keeps in touch with the various plants, advising and consulting the local superintendents. Accurate cost data are kept and in many instances a great saving has been accomplished, proving that close attention to this important question is worth while.

It is not possible for all operators to employ a blasting superintendent, but it is within their power to see that the blasting is under the supervision of an intelligent foreman.

The man should keep and render daily a report to the office showing the quantity of explosives used that day, the purpose for which they were used and where, with remarks showing the results obtained in the blast. In this way only can a reliable cost record of any value be obtained. He should be required to see that explosives are properly stored and properly used. He should keep a record of stock on hand, see that the oldest stock is used first, anticipate his needs far enough ahead to avoid running out and report these to the superintendent. It is within the power of the blaster either to save or waste a considerable amount of money. It is advisable therefore that an incentive should be given good men to take that position by making the remuneration commensurate with the danger and responsibility involved.

In conclusion, let me state that while undoubtedly there has been an awakening of interest in explosives among quarrymen, there is still room for further improvement along this line. Much is still to be done in the way of reducing waste and increasing efficiency and economy in quarry blasting.

The Pay of Technical Engineers in Railway Service

Some interesting points regarding the compensation of technical engineers in railway service were brought out in a statement submitted April 15 to the United States Railroad Labor Board by A. M. Van Auken, Chicago. We quote from his statement as follows:

The increase in wages of railroad employes and groups between the years 1892 and 1914, when the classification was changed, is shown by the records of the Interstate Commerce Commission to have been as follows:

	Average per day 1892	Average per day [illegible]	Average per day 1914	Per cent increase 1892-1914
[illegible] general officers	$[illegible]	$[illegible]	$[illegible]	111
[illegible] officers	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	27
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	24
[illegible]	[illegible]	[illegible]	2.54	15

Engineers under the Adams Classification, under which accounts were kept in these years, were included under "Minor Officers" and "Clerks."

The Bureau of Railway Economics compiled from the reports to the Interstate Commerce Commission and published on May 9, 1921, the figures from which the following are abstracted:

	1916. No. emp.	1916. Av. S.	1920 No. emp.	1920 Av. S.	Per cent inc. 1916-1920
General officers	[illegible]	[illegible]	[illegible]	$[illegible]	120.[illegible]
Division officers	[illegible]	[illegible]	[illegible]	[illegible]	166.1
Assistant engineers and draftsmen	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M. of W. and S. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
All [illegible]					[illegible]
All [illegible]					[illegible]

The technical engineer's salary is a very small item in the entire payroll of the railroads. From the same source as above the following figures are taken:

	1916	1920
Total compensation paid to all employes	$[illegible]	$[illegible]
Total compensation paid to engineers and draftsmen	[illegible]	[illegible]
Ratio percentage of [illegible]	[illegible]	[illegible]

Considering that the work of valuation was not well under way in 1916, and the large increase in that division of work in the period considered, the increase in number of employes in the latter year appears modest. It will be noted that the percentage paid for engineers service had shrunk materially in comparison with the total payroll.

The technical engineer's salary is but a small item in the cost of the work he designs and supervises. The following figures are from the same source as the last two:

	1916	1920
Expended for maintenance of way and structures	$[illegible]	$[illegible]
Compensation of assistant engineers and draftsmen	[illegible]	[illegible]
Percentage of expenditure for salaries	[illegible]	[illegible]

It will be noted that the percentage of expense for engineers and draftsmen was less than half in 1920 of what it was in 1916.

Figures are not obtainable to show the losses in dollars, to say nothing of the loss of life, which results from lack of inspection and supervision of track and structures by highly skilled men.

Figures of the American Railway Association show that rail failures per 100 track miles have been reduced by more careful supervision by the railroad engineers from 398 on 1908 to 82 in 1915. That refers to the rails rolled in those years. Can we estimate the value of property and number of lives which this one item has saved?

One instance where a passing track had been laid in such a manner as to nullify the derail at a railroad crossing cost many lives and more than five years cost of an adequate engineer department.

Considering the small relative cost of the engineering organization in the total expense of railroad operation and the large item which is affected by the difference between fair and best design, I would ask that your honorable board give serious consideration to the interests of those whose investments are rendered safe or periled by proper supervision, and the public and employes whose lives are periled by unsafe design or improper installation.

Novice engineers, overworked engineers, engineers who have not opportunity to supervise and observe, cannot protect. The force should be adequate, able, and imbued with utmost loyalty.

A study in 1918 of the cost in the years 1916-1917 of a college course, carefully considering all phases of the matter, showed that at nine technical schools the average minimum cost of an education, four years' course, was $5,220. It would probably be almost double now. In comparing the pay of the engineers with other classes, it should be kept in mind that the engineer has invested this amount of money and four years of time in himself, and should be given consideration accordingly. He is, also, probably a more ambitious man, else he would not have persevered for his education.

The nature of the engineer's employment and training tends to bar him from advancement in the broader fields of railroad service. He suffers from departmentalism. A study made in 1918 of ten engineering graduates who entered railroad service in 1898 and ten clerks who entered the same service at about the same time indicates that the chance for advancement is not markedly in favor of the engineer. The following figures show the result of the study:

	Clerks Max.	Clerks Min.	Engineers Max.	Engineers Min.
Salary in 1898	$[illegible]	$[illegible]	$[illegible]	$[illegible]
Salary in 1918	450	175	[illegible]	125
Average salary for 20 years	245	108	186	90
Average salary of all ten 20 years		[illegible]		120

L. A. Downs, vice president and general manager of the Central of Georgia R. R., in his address on opening the annual convention of the American Railway Engineering Association in Chicago on March 14th, 1922, made the following statement as reported in the Daily Railway Age:

"I sent a questionnaire to 19 Universities a short time ago, 19 representative schools of the United States, to which I received 15 replies. Out of these replies there were twelve that gave definite information as to their graduates. During the past 10 years, from 1911 to 1921, there were 3,003 graduates in civil engineering, and, surprising as it may seem, only 272, or 9 per cent are working for railroads. I did not find out how many of the engineering departments of the railroads were graduates of engineering schools, but in the case of two railroads, where I had a count made, that employed about 350 engineers, only about 50 per cent are graduates of technical schools. Something must be done to bring trained men into railroad work.

"In the southeast I made a canvass to discover what wages are paid to the young engineering graduate who desires to enter railroad work in the engineering department, and I found the average salary is $118 monthly. I am not in sympathy with the so-called welfare work of another engineering society in its uplift of wages, but I want to say that if the managers of the railroads of the United States want the services of trained men they must fix some attractive wage for the college graduates to start on. When we pay a fireman $175 a month to start, a flagman $141, a switchman $181, a car repairer $143, and a graduate of a technical engineering school $118, there is something wrong with the principles of the wages paid on railroads."

11 Types of Railroad Crossings

In recent years numerous types of track crossings have been built by the railroads. Selections of these were brought to the attention of the Committee of the American Railway Engineering Association, [illegible]. A large amount of valuable information regarding these crossings was given in a preliminary report presented last month at the annual convention of the association. An abstract of the report follows:

[illegible] crossings grouped as [illegible] with the [illegible] of their construction and [illegible] below; the figures under the group headings indicate the number of crossings of that group reported to the [illegible].

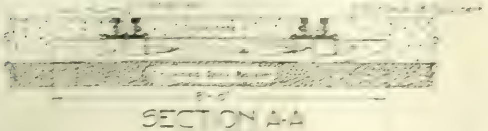


Fig. 1—Monolithic Concrete Crossing, M. St. P. & S. S. M. Ry., Waukesha, Wis.

Concrete	(a)	Solid concrete
[illegible]	(b)	Concrete slab
	(c)	Concrete plank
Bituminous material	(a)	[illegible]
[illegible]	(b)	[illegible]
	(c)	[illegible]
	(d)	[illegible]
	(e)	[illegible]
	(f)	[illegible]
Steel or Iron	(a)	[illegible]
[illegible]	(b)	[illegible]
	(c)	[illegible]
Paving Blocks	(a)	[illegible]
[illegible]	(b)	Brick
	(c)	Wood
Ballast material	(a)	[illegible]
[illegible]	(b)	[illegible]

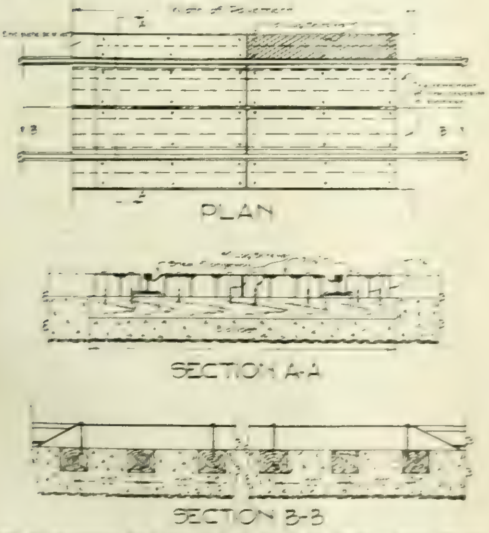


Fig. 2—Concrete Slab Crossing, C. M. & St. P. Ry., Cedar Rapids, Iowa.

The information presented covers 41 individual crossings, many of which were visited by members of the committee. Data in regard to others was obtained from railroad men and from the manufacturers. For the most part these crossings have been in use but a short time and definite conclusions as to maintenance cost and serviceability cannot be reached.

Briefly summarized, the status of each group is as follows:

Concrete—

(a) Solid Concrete—

We do not find many crossings of this type, and where used they have been on tracks where there is little railroad traffic.

(b) Concrete Slab—

This type of crossing has been built on a number of railroads [illegible] of various designs. Most of the installations have been made subsequent to 1919 so that they have hardly been in service long enough to furnish information as to their durability and cost of maintenance. One thing that has been demonstrated is that when concrete slabs are used, crossings should have good drainage to prevent heaving in winter time.

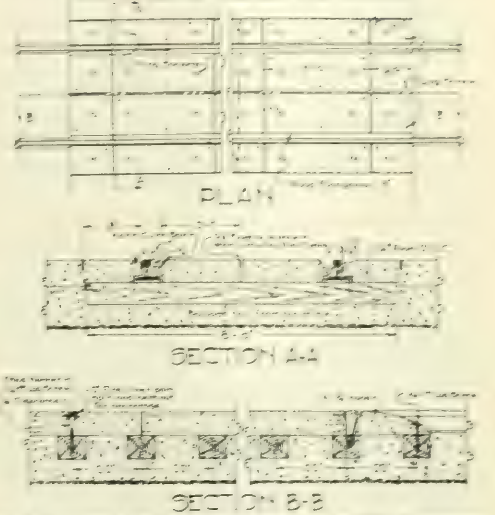


Fig. 3—Concrete Slab Crossing, Illinois Central Ry., Champaign, Illinois.

(c) Concrete Plank—

The C. B. & Q. R. R. has tried out a number of these crossings. The main trouble seems to be that the upper corners of the concrete plank disintegrate under service, indicating that such plank should have some sort of corner protection.

Bituminous Materials—

There are more crossings of this type of service than any of the others. The first cost of installation is lower and they are easily installed.

Steel or Iron—Plate Type—

This type of crossing is not universally used and seems to be in an experimental stage. One of these was installed in 1920 by the C. C. C. & St. L. Ry. at [illegible], O. After a service of eighteen months it was taken up on account of the plates not being heavy enough to carry the traffic which passed over them. These crossings are now being made of heavier material. One will be installed on the B. & O. R. R. at Cincinnati, O. There seemed to be a tendency for horse-drawn vehicles to avoid this type of crossing when possible.

Railroad Rails—Steel or Iron—

These crossings consist of rails laid between the running rails, and spaces filled in with concrete or other material. They have not been used on high speed tracks.

Paving Blocks—

This type of crossing is used mostly in cities and particularly where the adjacent street is paved with blocks or where [illegible] requires their use.

Ballast Material—

Crossings of this type seem to be used mostly at farm crossings and on highways with light traffic.

Further details regarding the various types of crossings follow:

Monolithic Concrete Crossing, M. S. & P. & S. S. M. Ry., Waukesha, Wis. (Fig. 1).—This crossing was installed in 1921. Cost per sq. ft. [illegible]. Average number of vehicles crossing per 24 hours [illegible].

Old ballast was removed and replaced with crushed rock and new ties were put in. The railroad company put track in shape and fastened guard rails. Concrete was placed by contractor who paved street. Concrete extends from bottom of the bottom of ties and between main rail and guard rail up to the top of the [illegible] in. bolt tying them together. Contract price for paving was 15 ct. per sq. ft. This does not include any work done in preparing the roadbed or track.

This crossing has been in service about 6 years. There has been no maintenance connected with it except for the cracks the total cost being about $5.

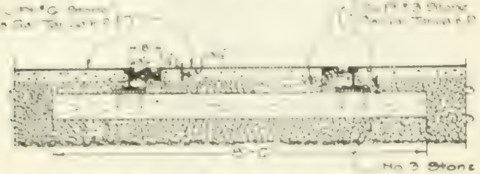


Fig. 4.—Tarvia K. P. Crossing, B. & O. R. R., Dayton, O.

Concrete Slab Crossing, C., M. & St. P. Ry., Cedar Rapids, Ia. (Fig. 2).—Crossing installed March, 1918. Cost per sq. ft., 57 ct.

Concrete slabs were installed on two tracks of the C., M. & St. P. Ry., one track C., R. I. & P. Ry., and two tracks of the C. & N. W. Ry. The street is paved with asphalt with the exception of the crossings. The five tracks are paved with concrete slabs between the rails and for a distance of 1 ft. 6 in. outside the rails. The tracks were not well ballasted before the installation and provision was not made for drainage. The cost of 57 ct. per sq. ft. is only the cost of manufacturing the slabs and does not include placing them.

The only maintenance expense incurred has been in removing the slabs to resurface the tracks. However, in the five tracks there are thirteen slabs that need renewal. Considering the traffic, these slabs are holding up fairly well, but have been more or less damaged by being picked up and replaced to permit resurfacing of the track.

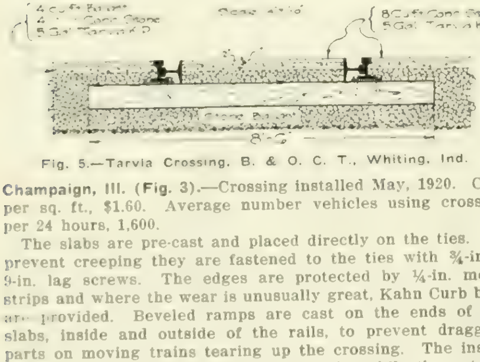


Fig. 5.—Tarvia Crossing, B. & O. C. T., Whiting, Ind.

Concrete Slab Crossing, Illinois Central Ry., Chester Ave., Champaign, Ill. (Fig. 3).—Crossing installed May, 1920. Cost per sq. ft., $1.60. Average number vehicles using crossing per 24 hours, 1,600.

The slabs are pre-cast and placed directly on the ties. To prevent creeping they are fastened to the ties with ¾-in. x 9-in. lag screws. The edges are protected by ¼-in. metal strips and where the wear is unusually great, Kahn Curb bars are provided. Beveled ramps are cast on the ends of the slabs, inside and outside of the rails, to prevent dragging parts on moving trains tearing up the crossing. The inside slabs are 5 ft. 6 in. long and 25 in. wide, while the outside slabs are 18 in. wide and the same length. Reinforcing rods used as shown in plan. The cost of this crossing was $1.60 per sq. ft. in place.

This crossing was installed May 26, 1920, and as yet shows no wear. There has been no maintenance expense and the crossing has proven entirely satisfactory.

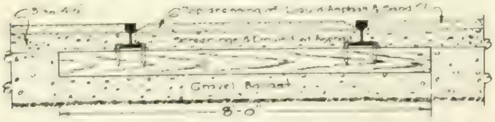

3 to 4½
Top dressing of Liquid Asphalt & Sand
Screenings & Emulsified Asphalt
Gravel Ballast
8'-0"

Fig. 6.—Emulsified Asphalt Crossing Central Indiana R. R., Anderson, Ind.

Tarvia K. P. Crossing, B. & O., 3rd St., Dayton, O. (Fig. 4).—Crossing installed October, 1921. Cost per sq. ft., 22 ct. Average number vehicles using crossing per 24 hours, 1,000.

Tracks were first put in good condition, ties renewed and fully tie-plated, ballast thoroughly cleaned to a depth of 6 in. below the bottom of the tie over the full width of the crossing. Tracks were lined and surfaced, rail renewed, if necessary, and good drainage provided. An 8-in. plank, 4 in. thick, beveled to provide the proper flangeways, was then placed on the inside of each rail and at the ends of the crossing, level with the top of the rail. While the above work was being done two mixtures of clean stone and Tarvia K. P. were made. One consisted of ¾ in. to 1¾ in. stone, and one of particles of stone up to ½ in. in size, mixed in the proportions of 1½ cu. ft. of stone to 1 gal. of Tarvia K. P. and allowed to cure for a period of 24 to 48 hours before using. After the mixtures were thoroughly cured the coarser one was spread over the roadway 2½ in. deep, and after being thoroughly tamped, a sufficient quantity of the finer mixture was spread over this to make it level with the top of the rail, after being thoroughly tamped and rolled. The city of Dayton furnished a roller to roll the crossing at cost.

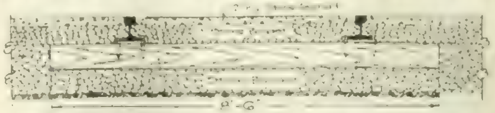


Fig. 7.—Kentucky Rock Asphalt Crossing, C. & O. Ry., Augusta, Ky.

Crossings of this kind which have been in service for two years have required only a slight amount of maintenance, which can be done at a cost of approximately 3 ct. per sq. ft.; others which have been in service on densely traveled streets required no maintenance after a period of one year. The city of Dayton at first objected to the installation of these crossings in 1918, but after allowing the construction of one crossing, are now insisting that all crossings be made of the same construction.

Tarvia Crossing, B. & O. C. T., 121st St., Whiting, Ind. (Fig. 5).—Crossing installed May, 1920. Cost per sq. ft. 33 ct.

Good drainage was first furnished crossing and track put in good condition with regard to ties and ballast. Stone ballast was placed to within 3 in. of the top of the rail. On top of this a mixture of 4 cu. ft. of ballast and 4 cu. ft. of concrete stone and 5 gal. of Tarvia K. P. was placed; on top of this a top dressing of 8 cu. ft. of concrete stone and 5 gal. Tarvia K. P. was used. The mixture was not rolled, as there were sufficient heavy trucks going over this crossing to act as a roller. On one installation stone screenings were tried, but it was found that they absorbed too much of the Tarvia, and therefore were not used in the crossing in question.

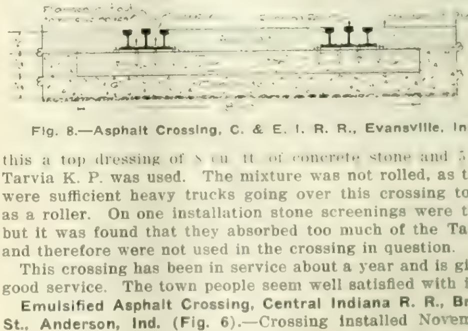


Fig. 8.—Asphalt Crossing, C. & E. I. R. R., Evansville, Ind.

This crossing has been in service about a year and is giving good service. The town people seem well satisfied with it.

Emulsified Asphalt Crossing, Central Indiana R. R., Brown St., Anderson, Ind. (Fig. 6).—Crossing installed November, 1920. Cost per sq. ft., 24 ct. Average number of vehicles using crossing per 24 hours, 500.

All ties and angle bars were renewed and rails tie plated. Crossing was then filled to top of rails with new gravel and allowed to pack for about two weeks. Surface was then removed to a depth of 3 in. to 4½ in. and emulsified asphalt, ready mixed, with screenings, applied, rolled or tamped firmly. Top dressing of liquid asphalt and sand then applied. No flange rail was used.

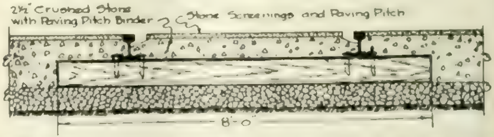

2½" Crushed Stone with Paving Pitch Binder
Stone Screenings and Paving Pitch
8'-0"

Fig. 9.—Paving Pitch Crossing, T. H. I. & E. R. R., Terre Haute, Indiana.

This crossing installed Nov. 12, 1920, is in excellent condition and has proven satisfactory in every respect. Used by about 500 vehicles every 24 hours.

Kentucky Rock Asphalt Crossing, C. & O. Ry., Augusta, Ky. (Fig. 7).—Crossing installed October, 1920. Cost per sq. ft., 26 ct. Average number of vehicles using crossing per 24 hours, 998.

Good drainage was first furnished crossing and track pulled and put in good condition as to ties and ballast. Stone ballast was then placed to within 2 in. of the top of the rail. On top of this was placed a mixture of Kentucky rock asphalt to a thickness of 2 in. The mixture was then rolled with a steam road roller and the crossing put in service.

This crossing has been in service one year and is giving excellent service. The town people are well satisfied with it, as many other crossings of the same material.

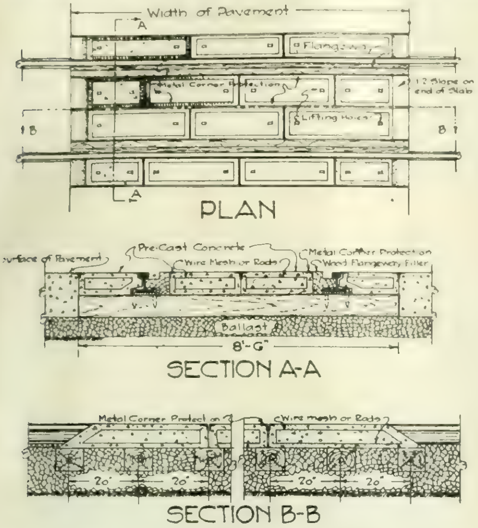


Fig. 10.—Steel Crossing, Plate Type, C. & N. W. Ry., Chicago.

Asphalt Crossing, C. & E. I. R. R., 1st Ave., Evansville, Ind. (Fig. 8).—Crossing installed, 1921. Cost per sq. ft., 75 ct. Average number vehicles using crossing per 24 hours, 1,000.

New ties were put in and rails tie plated. A concrete base was installed to a depth of 6 in. below bottom of ties. Rails were placed on each side of running rail and at ends to form flangeways and headers. These rails were notched out to fit close up to the running rail. A 5-in. standard asphalt street surface was then put on. Estimated cost was 75 ct. per sq. ft. On account of cutting out flange rails for spikes by hand, the cost was much larger than it would have been if notches had been burned in with acetylene torch.

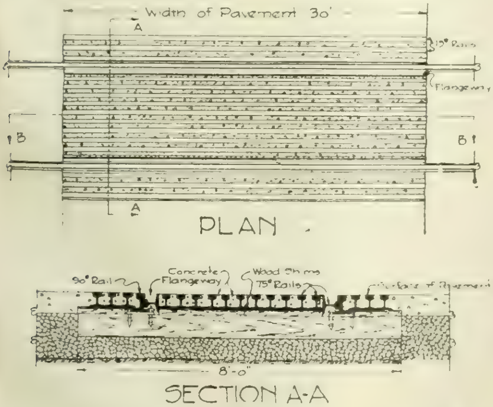


Fig. 11.—Steel Crossing, Railroad Rails, C. I. & L. R. R., Lafayette, Ind.

This crossing is in excellent condition. Has been in service for about six months and shows no sign of wear under heavy traffic.

A Paving Pitch Crossing, T. H. & E. R. R., Terre Haute, Ind. (Fig. 9). Crossing installed, 1919. Average number of vehicles using crossing per 24 hours, 1,200.

Ballast was removed to bottom of ties and then large size crushed stone put in and hot paving pitch poured on. Next a dressing of screenings and another coat of paving pitch. Thoroughly tamped in place. Standard Asphalt Refining Co.'s paving pitch used. No cost data available.

Crossing was damaged in 1920 by an interurban car leaving track and was patched with Tarvia. Also patched by Indiana State Highway Commission with emulsified asphalt. Apparently giving good service under heavy traffic.

Steel Crossing, Plate Type, C. & N. W. Ry., Chicago (Fig. 10).—Crossing installed February, 1921. Average number of vehicles using crossing per 24 hours, 900.

Crossing was installed by the manufacturers at their own expense. The ties were about 9 months old when the crossing was put in. It is fastened to the ties by 9 in. lag screws. No work was done on the track in preparation for the installation.

Present crossing has been in service about six or seven months. The lag screws are loose and the sections of the crossing work up and down under the heavy traffic. On account of being located on one side of the center of the street, it does not receive a fair trial. The rest of the crossing is planked. Horse drawn vehicles seem to avoid the steel, if possible. The loads passing over are heavy, and the top of the steel crossing is slightly bent. This might be overcome by placing a steel plate on top of the tie.

Steel Crossing, Railroad Rails, C. I. & L. R. R., Lafayette, Ind. (Fig. 11).—Crossing installed, 1915. Cost per sq. ft., 50 ct. Average number of vehicles using crossing per 24 hours, 300.

Ties and rails being renewed and light rail bases laid touching between the running rails and spaces filled with concrete. The first rail on each side being laid with the ball next to the running rail so as to form a flangeway.

There has been no maintenance to date and the crossing is in excellent condition. About 300 vehicles use it every 24 hours. The cost of the crossing depends upon the scrap price of the rail. The labor for installing is not much greater than that of 4-in. plank crossings.

Wholesale Prices of Building Materials

The following table, reprinted from the December, 1921, Labor Review of the U. S. Bureau of Labor, shows the wholesale prices of building materials at date peak was reached and in August, September and October, 1921, expressed on percentages or the average price in 1913:

Article.	Relative price		
	At peak		October 1921.
Brick, common, at kiln, average for United States	Aug., 1920	294.8	207.1
Gravel, at plant, average for United States	Dec., 1920	333.0	269.9
Hollow tile, Chicago	June, 1920	236.9	141.7
Lime, common, lump, at plant, average for United States	Oct., 1920	287.8	213.1
Portland cement, at plant, average for United States	Sept., 1920	214.2	170.8
Sand, at plant, average for United States	Dec., 1920	213.5	176.4
Slate, roofing, New York	Aug., 1920	257.3	220.5
Bars, reinforcing, Pittsburgh	July, 1917	327.1	119.9
Nails, wire, Pittsburgh	Jan., 1920	252.9	164.9
Structural steel, Pittsburgh	June 1917	331.0	115.9
Roofing tin, Pittsburgh	Nov. 1917	220.5	167.2
Cast-iron pipe, New York	Sept 1920	330.1	202.4
Douglas fir, No. 1, at mills	Jan 1920	407.3	114.6
Hemlock, Chicago	Mar., 1920	256.2	128.7
Lath, at mills	Feb., 1920	456.8	137.9
Red cedar shingles, at mills	Feb., 1920	346.8	168.8
White oak, Cincinnati	Mar 1920	388.1	146.6
Yellow pine flooring, at mills	Feb 1920	455.3	184.8
Timbers, southern yellow pine, at mills	Mar., 1920	317.5	134.4
Plate glass, New York	Aug., 1920	329.7	253.5
Window glass, New York	Aug 1918	295.2	231.0
Linseed oil, New York	Aug 1919	480.1	147.2
Putty, New York	Jan 1920	226.1	179.2
Turpentine, New York	Mar 1920	601.8	176.4
White lead, New York	Mar 1920	229.3	181.2

The above prices were obtained either by averaging reports from a number of producing areas or by using quotations from a single representative market as indicative of prices in other markets. In all cases the information is believed to indicate correctly the trend of prices for the country as a whole.

Some Conclusions on the Construction Situation

Summary of Address April 4, Before National Federation of Construction Industries

By HERBERT HOOVER

During the past ten months the Department of Commerce has given intensive study to the situation in the construction industry; to the national needs in building and construction; to the manufacture and distribution of materials to construction, to its finance, and to its conditions of labor. We have studied the form of trades organizations and their practices. I have had the advantage of conferences with many hundred leading manufacturers, engineers, architects, contractors and labor leaders.

The department has been systematically co-operative with the industries, endeavoring to give such assistance as the government can properly take in relief of the housing shortage. I believe much has been accomplished.

I have been urged by the leading men in these activities that I should take this occasion to frankly express our conclusions in the matter. This can be done very simply.

First: The practices of some small minority are unendurable. They smear with shame the high standards of American business and labor, they drag in disrepute that vast majority of good men in these vital industries. This situation simply must be cleaned up. The government can catch occasional crooks but the cleaning can be done infinitely better by the decent men in the industry if they will organize to do it. It must be done if we would protect our business and commerce from the steady invasion of regulatory hands of the government. I wish to emphasize again that the vast majority of men in these industries do not engage in these practices but some out of self-defense are forced into them by others.

Second: A great field of service to the industry itself and to the country as a whole lies in the elimination of those great indirect wastes which are beyond the control of any one individual man or concern and can therefore only be accomplished by associated action. And if we would secure the housing and construction now so badly lagging behind our needs, we must cheapen its costs. It can be cheapened at a gain in stability to the industry and still hold high standards of living amongst the vast army of workers in the industry. Efficiency in industry is more important to the nation than the margins of profit or the rates of wages over which we do most of our quarreling.

Third: To accomplish these ends, we need cleaner organization of the trades, not the destruction of trades organization. The initiative of the single individual is the most precious part of our whole economic fabric. But there are limits beyond which if we would make the full field of national efficiency, we must have co-operation between individuals. This is not a limitation of individual initiative; it is an extension of it. The restraint of crooks does not necessitate the restraint of constructive action for better business practices.

In the matter of business and labor practices of the minority, I need not recite the repeated exposures in all directions that have sickened the public during the past twelve month. There are other things that have not yet been exposed. I have no taste for demagogic statements. I do have an aspiration for constructive remedies.

Let us take a single material, lumber. Several leading manufacturers inform me that the time has come when we must have a guarantee against short deliveries and fraudulent alteration of qualities. The product of the honest miller must reach the consumer as the manufacturer wishes his product to reach the consumer. Also, he must have protection from the crooked competitor. Is it not possible for the National Lumber Association to take upon itself the duty of giving a brand to lumber that will show its content and grade. Many commodities are assured as to quantity and grade under the inspection and rules of our voluntary trade associations. If you think it wiser to do so, we could probably secure the enactment of a "Pure Food Law" in all building materials. I would much rather see the trades themselves establish their own standards.

We need a cleaning up in the statistical work of the trade associations. Some kinds of this work stand condemned in the courts as a restraint of trade and against public interest, yet other kinds of statistics are in the interest of the public as well as in that of the trades themselves and have not been condemned.

We need in our organized labor a removal of every restraint upon effort. No thinking man wants over-long working hours. What is wanted is the full, complete effort of every man during his working day within the utmost of his ability. We need a further vision in the labor world that the volume of employment is not increased by restriction upon effort. The absolute contrary is the case. There can be no answer to the fundamental fact that the standard of living of all the people is the simple quotient of the commodities and services we produce. The more we cheapen the production of a commodity, the larger the number of people who can obtain it. Restriction upon effort in the building trades simply reserves the better class of buildings and of homes to the better-to-do fraction of our people. At present costs, it is scarcely possible for a worker from his own income to build a new and ample home. We want a nation of home owners. There are more buildings needed and in position to finance themselves than there are skilled workers to build them if we could reduce the costs of building. Any justification of those employers opposed to organized labor would disappear at once if labor used its organization to promote the best effort of its members.

Labor has a large field of service in the further elimination of jurisdictional disputes, the removal of all restrictions on effort, the elimination of restrictions on the use of materials. This requirement for full effort applies to those who work in hard collars as well as to those who work in soft collars. The standards of living to a large part of our people are higher than in any other part of the world today, but if we would extend these standards to the remainder of our people, it will be done only by full effort and the elimination of every waste in industry.

This brings me into the area of my second theme—the elimination of waste in manufacture and distribution. I do not intend to enter into details, for I need only to mention the questions of simplification and standardization of dimensions and of quality, the standardization of buying and selling specifications, the greater uniformity in construction contracts, the simplification of building codes, and the better synchronizing of different construction industries towards the elimination of intermittent employment.

The term "simplification" we have been using to cover reduction in the tremendous wasteful range of varieties in nearly all products. You gentlemen will certainly admit that the dimension of varieties of almost every component in construction industries can be halved or quartered to the great advantage of all groups. These economies in production and construction ramify into everything from bricks, lime, stone, lumber and hardware, to paint. These efforts do not need to trespass the field of variety and style nor to undermine the distinction of any manufacturer. They can be accomplished in no way except through the voluntary action of trade associations and thus through co-operative effort in the trades.

In these trades there are three groups of organizations:

First: Of the producers and distributors of materials.

Second: Of the representatives of the consumers through the contractors, architects and engineers.

Third: Of labor through the different trades.

I have before me a proposal of the consumers' associations to consolidate their organizations and to demand certain standards both of business ethics and products from the producers and distributors of building materials. I believe co-operation is better than antagonism, and if the right and forward thinking men on both sides can get together, they can solve these situations.

I have in my mind such a case recently where the paving brick manufacturers co-operated, through the Department of Commerce, with the municipal engineering associations to reduce the variety in the dimensions of paving bricks from over sixty in number to seven to the mutual benefit of the manufacturers and the public.

And this brings me again to trade associations themselves, whether manufacturers, distributors or workers. I believe in them. They are a complete necessity in our growing economic life. They can and have been misused. They can make for stability and economy in industry and for public welfare. Their two greatest fields of usefulness lie in the lifting of moral standards in these trades and in the increased efficiency of our production and distribution.

This question of reduction of national waste is one of our first problems as a nation. If we would recover the losses of war, if we would hold our own in foreign trade, if we would maintain and increase our high standards of wages and living at home, it can only be accomplished by cutting out our national lost motion and waste. The building trades can pioneer a great trail of national advance in this direction.

It has been my ambition that the Department of Commerce should co-operate with every rightful effort to accomplish these purposes; that it should never attempt to dictate to our business or commerce; but that it should itself be part of the co-operative effort of the whole community to our economic betterment. It is in this vision that we offer you our assistance and help. In the development of a sense of co-operation in industry, to these ends we will reinforce the foundation of our economic life in individual initiative—not in the patent medicines of government interference.

Ditching on Rock Island Railroad with Spreader Ditcher

Expenditures for general ditching over the Chicago, Rock Island & Pacific R. R. during the past six years have averaged $900,000 annually, the work being done by section men, extra gang laborers and teams, supplemented by steam ditchers, of which this company has 12, the use of the latter being confined principally to cleaning out heavy cuts, by loading material into cars and dumping same on embankment.

A Jordan spreader ditcher operated by locomotive was put into experimental use on the Rock Island in the early part of 1920 and the results were so satisfactory that one complete machine was purchased in 1921, also a ditching attachment. The company now possesses three complete ditching machines, added to the leveling machine previously owned by the railway.

The total figures of the comparative amounts expended for hand, team and mechanical ditching are not available for past years, but in 1920 alone over $300,000 was expended for team ditching. With the advent of the three mechanical ditchers, supplemented by the twelve steam ditchers now owned by this company, it has been possible to eliminate entirely all team work for ditching, except for some minor work at the foot of slopes, or at points where it was impossible to operate mechanically.

The following figures on the operation of these spreader ditchers are taken from the January, 1922, issue of Rock Island Magazine:

In August and September, during the period of observation taken for cost, spreader-ditcher No. 95303, operating on the El Paso-Amarillo Division, moved 29,000 cu. yd. of material at a labor cost of $386, equivalent to a cost per yard of $0.0133.

During the same period machine No. 95,302, operating on the St. Louis-Kansas City Division, moved 28,000 cu. yd., at a labor cost of $507, equivalent to a unit cost per yard of $.018.

A careful check has been made of the work being done on various divisions by hand during this period, where mechanical ditching was not available, the costs running variously from 60 ct. to 90 ct. per yard, although special cases are reported of from $1 to $1.60 per yard, where the material was of a heavy character. A similar check has been made for the contract team work during 1920, with the rates equalized so as to afford direct comparisons. These costs vary from 25 ct. to 60 ct. per yard.

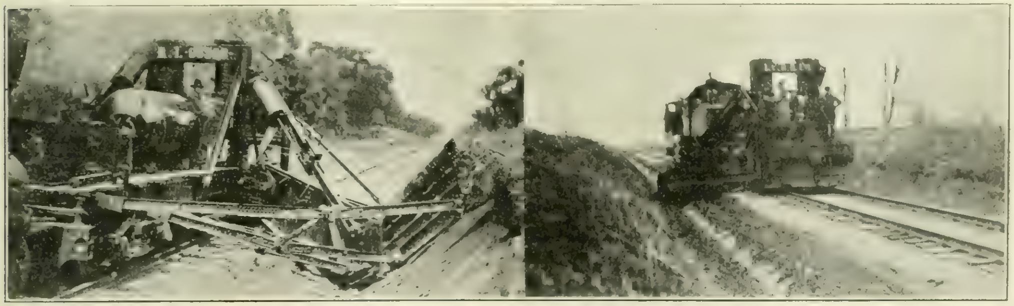
The above costs are for labor only. The costs for operation of the spreader-ditcher on two 1921 jobs, including interest on the investment, depreciation, engine rental, etc., are given as follows in the Rock Island Magazine:

On El Paso Division from May 16 to May 21, 1921, between Amarillo, Tex., and Tucumcari, N. M.:

	Miles.
Total miles ditching done	58.25
Total miles spreading done	9.75
Total miles roadway completed	68.00
Six days at $77.94 (which included cost of spreader operator, train crew, fuel, section laborer and watchman)	$467.64
Engine rental, 6 days at $25	150.00
Interest, depreciation and repairs	18.00
Total cost	$635.64
Cost per mile of roadway completed	9.35
Cost per lineal foot of roadway completed	.0017

In August, ditcher-spreader No. 95,303, operating on the St. Louis Division, leveled an embankment 4,000 ft. long, material having been placed there by steam ditcher. This consisted in the leveling of about 11,000 cu. yd.

The material was leveled back in short order at a cost of $.013 per yard. Comparison on the basis of similar performances done by teams, this job would have cost 38 ct. per yard.


Ditching with Spreader-Ditcher.

The following is detail:

Cost of operation, including operator, helper, train crew, coal, oil and supplies (11,260 yd.)	$120.00
Engine rental	25.00
Interest on investment, depreciation and repairs	3.00
Total cost	$148.00
Cost per yard by spreader	.013

Weather Charts Save Railroad Money in Placing Ties.—The relationship between railroad ties and weather reports would seem to be rather distant, but a report received by the Weather Bureau of the United States Department of Agriculture from one of the large railroad systems of the west shows that the rainfall charts prepared by the bureau saved this railroad a large amount of money. During the war this road was unable to get creosote and had to substitute zinc chlorid as a preservative for ties. The zinc salt is a satisfactory preservative in dry climates, but where the rainfall is heavy it leaches out. When the war ended this company had on hand 2,500,000 ties that had been given the zinc treatment. Instead of re-treating them with creosote, the engineers secured a Weather Bureau chart and transferred the lines of average precipitation to a map of the system. Then they distributed the zinc-treated ties for use on those parts of the road in relatively dry regions.

Janesville, Wis., to Have City Manager.—By a majority of 711 the city manager plan of government was adopted by Janesville, Wis., at an election April 11. The plan will go into effect April 1, 1923.

Valuation of New York City Traction and Rapid Transit Properties—Tentative Details*

The main details of the preliminary valuation report prepared by the New York Transit Commission for the rapid transit and surface passenger railway systems in the City of Greater New York as a basis for the proposed merger plan were outlined in connection with the capitalization of each system in the "Chronicle" of Feb 25, p 803 to 805. It should be remembered, however, that while the valuation covers all lines operating or in condition to operate, the Commission favors the retention only of the really desirable lines.

A much condensed digest of the text of the report and the valuation table in some detail follow.

Valuation Required by Law—Omits Franchises and Going Value.

The Act of the N. Y. Legislature creating the Transit Commission provided that the Commission prepare a plan of readjustment for the improvement of transit in Greater New York by combination, rehabilitation and extension of existing railroads and in that connection provided that with such plan "the Commission shall cause a valuation to be made of the property, other than franchises or going value, necessarily used in public service of the railroad companies to be included therein, such valuation to be made with due regard to the estimated prospective earning capacity of the property under existing rates of fare, and as finally determined to be the basis for all allowances to the railway companies under the plan and for thereafter fixing the returns on the property so valued."

The Report. Accordingly, there have been prepared as of June 30, 1921, for each railway company or system proposed to be included in the plan of readjustment the following:

(1) Valuation of property used and not used in operation, based on (a) Actual or estimated original cost, (b) Cost to reproduce new in pre-war period (1910 to 1914), (c) Cost to reproduce new January to July, 1921.

(2) Valuation of property less accrued depreciation on straight line basis, for all three periods.

(3) An estimate of amount necessary to place each property in first-class operating condition.

(4) Capitalization, book value and financial data, for each company.

(5) Operating statistics for each, over a period of the past ten years.

(6) Other relevant data respecting valuations, operating conditions, etc.

Scope of Report. This report embraces all transit companies operating within the limits of Greater New York, except the Hudson & Manhattan Railway Co. and the Staten Island Rapid Transit Co., which are not included in the present plan.

The summaries include all companies in the railway systems constituted in 1914 before the disintegration began; but those portions now operated independently are also shown separately.

Valuations. At the outset it will be realized that a valuation for the purpose of acquisition of railroad properties is not identical with a rate case, and the procedure is not as restricted by technicalities. A rate case may well involve a consideration of intangible values which do not necessarily assume importance in the determination of a fair value for property to be acquired as used and useful for the operation of a railroad.

For all property included in this report the inventory was made as of June 30, 1921.

The railroad companies included in the valuation comprise street surface lines and rapid transit lines. The latter are the subway and elevated railways in all boroughs which are operated under the so-called "Dual Contracts" and related certificates of March 19, 1913, and Contracts Nos. 1 to 3. In the case of the Interborough and Manhattan, the valuation of construction under the contracts was based upon the ascertained or determined cost as reflected by the records of the Commission and no other estimate was made as to reproduction costs or otherwise.

For [illegible] for the property [illegible] the original [illegible] the valuation was developed on three bases: the valuation of all physical property based on (a) The original cost or an approximation thereof, (b) the cost to reproduce new at prices and conditions existing from 1910 to 1914, (c) the cost to reproduce new at prices and conditions existing in the first six months of 1921.

The term "reconstruction cost" in the Act is held to be synonymous with "reproduction cost" as employed in valuation work.

"Original cost" represents the expenditure to produce the property in its present condition, as of the date of inventory. "Costs to reproduce" represent expenditures which would have been necessary to reproduce the property at the two periods selected, the second period being the first six months of 1921, which was immediately preceding the completion of the inventory, and intended to reflect the then "present day" prices and conditions. In the half year which has elapsed since this latter period the price level has materially receded and the "Cost to reproduce" as of Jan. 1, 1922, would reflect a marked reduction in the estimate as presented for the first six months in 1921.

In the two estimates to "Reproduce new" it was assumed that the property would be reproduced in "like" and not in "kind" which would apply for example in the substitution of steel for the wrought iron of the original elevated railway structures and the substitution of modern type of substation equipment where the manufacturer had discontinued the original design in favor of an improved type.

In addition, a statement is being compiled of the estimated prospective earning capacity of the transit property necessarily used in the public service at the rate of fare in effect prior to the enactment of the legislation. This will be the subject of a subsequent report.

Estimates were prepared of any claims presented by any company for consideration in the valuation of property not now existent, but such estimates were intended to make all facts available to the Commission and in no way involved any recognition as to their validity or to commit the Commission to any allowance therefor.

Companies' Appraisals and Inventories.

The appraisals applying to New York Railways System and the Brooklyn Rapid Transit Co. surface lines, which were previously made for the companies by engineering firms of standing are presented as contemporaneous exhibits segregated into the significant factors of the values placed on the properties and the results have been brought down to June 30, 1921, by the Bureau of Valuation by applying the adjustments reflected by the capital accounts of each company.

For the Manhattan Railway Co. an exhibit is presented showing appraisals made in connection with the proceedings by the company against the State Tax Commission, contesting the assessment levied on the value of the special franchises between 1900 and 1909.

The property included in the companies' reports may not be identical with that appraised by the Commission through a difference in the allocation of ownership within a system as well as in the distribution as to operative and non-operative property particularly as respects land and buildings. Furthermore the appraisal for the Brooklyn Rapid Transit Co. was prepared for a rate case and included only such of the property as was to be presented for consideration in that proceeding; this appraisal has recently been brought to March 31, 1921, by the company.

The inventory includes all property in existence as of June 30, 1921, except such items as track which was abandoned and allowed to disintegrate so as not to be useful for operation.

Inventories, Etc., As Valued by the Commission.

The inventory for the valuation however was set up after segregating the property into operative and non-operative, the latter including principally buildings and power plant and substation equipment retained by the companies but not utilized in the operation of the railroad.

The inventory includes all property and equipment deemed to be essential for the operation of the railroad even though as in one instance a parent company claims ownership of a main power plant and alleges it furnishes current for operation as a commercial enterprise and that its property should not be included with that of the operating companies in arriving at a total valuation for the system. [This, no doubt, refers to the powerhouse, the ownership of which is claimed both by the Brooklyn Rapid Transit Co. and Brooklyn City R. R.] It was considered that if the property was to be acquired the power plant essential to and operated solely for the purpose of the railroad must be included in the transaction.

When the ownership of any property was in dispute between the companies included in a system it was allocated to that company holding such property in its possession.

Pricing of Inventories.—Whenever possible an endeavor was made to establish the original cost for each item of property with the date of its installation or acquisition. An exhaustive study was made of the prices of materials and the rates for wages by years from 1890 to 1921 so as to determine the factor to apply to convert actual costs to the years when costs were not available or could not be secured.

Quotations were obtained from manufacturers and from previous commission appraisals. Estimates of all quantities entering into the construction of the railroad were confined to the actual net lines of the completed structure. For property constructed or acquired subsequent to 1914 the actual cost thereof was adopted in the estimate for cost to reproduce from 1910 to 1914 as well as for the estimate of original cost.

Basis Assumptions—Overhead Charges, Lands, Etc.

Unit Costs.—To arrive at an equitable valuation of the street surface railways certain basic assumptions must be made, since the properties are being valued as the existing type of electric operated railways, whereas except in a few instances they were originally built and operated as horsecar lines and were converted from time to time over a period of years.

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*From Commercial and Financial Chronicle, Mar. 25, 1922.

TENTATIVE VALUATIONS OF OPERATING PROPERTIES OF RAPID TRANSIT AND SURFACE RAILROADS—NEW YORK CITY—AS OF JUNE 30 1921

(Showing results on basis of original costs, and prices of 1910 14 and 1921, less depreciation. Also the cost, in last column, of non-operating properties, less depreciation.)

Name of System or Company.	Original Cost Valuation of Operating Property	Needed to Place Property in First Class Condition.	Net Valuation	Capital Stock, Bonds, &c., Held by Public June 30 1921 f	Company's Book Value Fixed Capital Assets June 30 1921.	Appraised Value of Operating Property on Basis of (1) Original Cost: Accrued Depreciation.	(1) Original Cost: Cost Value Less Deprec	(2) Prices 1910 14 Value Less Depreciation	(3) Prices 1921. Value Less Depreciation	Details of Net Valuation [illegible] Based on Prices of 1921: Track and Structures	Electrical and Mechanical Equipment	Rolling Stock	[illegible]	[illegible]	Land	Right of Way	Non-[illegible]
Brooklyn Rapid Transit (1) Surface Lines—	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$
Brooklyn Heights RR	769,582	85,459	684,113		13,506,413	316,009	453,573	594,563	836,381	507,957	26,174	123,500	90,900	11,736	[illegible]	9,000	40,775
Bridge Operating Co.					100,735												
Brooklyn Queens County & Suburban RR	4,474,015	1,122,849	3,351,196	No details shown because of inter company holdings	11,431,567	1,859,019	2,614,996	3,076,297	5,531,766	3,018,036	705,620	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
Coney Island & Brooklyn RR (incl. leased)	5,525,989	1,354,121	4,171,868		9,611,765	2,235,832	3,290,157	3,703,212	6,629,942	3,335,521	344,701	1,711,500	700,000	[illegible]	[illegible]	[illegible]	[illegible]
Nassau Electric RR	11,540,755	3,313,216	8,227,539		31,867,626	5,060,756	6,179,999	7,579,345	13,376,733	6,938,819	697,314	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
Brooklyn Rapid Transit Co.	23,654,969	2,048,553	21,606,416		17,201,213	6,903,415	16,751,554	17,028,205	27,214,990	6,242,700	9,221,418	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
Total receivership surface companies	45,965,340	7,924,208	38,041,132		86,722,349	16,375,061	29,590,279	31,951,622	53,389,812	20,073,036	10,995,257	12,084,000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Brooklyn City RR Co.	20,431,352	4,813,508	15,587,844		19,837,531	7,859,279	12,572,173	14,492,613	26,594,934	16,076,923	1,847,146	3,512,500	[illegible]	[illegible]	[illegible]	73,700	[illegible]
Coney Island & Gravesend Ry.	416,112	75,614	370,498		251,480	195,641	250,171	280,322	550,224	284,418	2,906	202,100	60,800				
South Brooklyn Ry. (including leased)	5,086,153	573,868	4,512,285		4,031,189	972,111	4,113,639	4,311,623	6,011,670	1,926,930	303,562	876,800	[illegible]		[illegible]	[illegible]	[illegible]
Total B. R. T. surface lines	71,928,957	13,417,198	58,511,759		110,812,552	25,402,395	46,526,562	51,066,180	86,746,640	38,361,307	13,149,201	16,675,400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
B. R. T. (2) Elevated & Subway Lines—																	
N. Y. Consolidated RR—original property	24,761,992	2,357,117	22,404,875		58,497,742	7,818,180	16,943,912	16,740,458	29,490,822	14,442,645	912,240	7,240,200	[illegible]	1,026,200	[illegible]	[illegible]	[illegible]
New York Municipal Railway Corporation—																	
Contract 4 construction and equipment	41,672,294	a1,230,918	40,441,376			1,230,918	40,441,376	40,441,376	40,441,376								
Reconstruction of existing railroad	19,302,186	a75,262	19,226,924			75,262	19,226,924	19,226,924	19,226,924								
Additional tracks	8,194,726	a13,659	8,181,067			13,659	8,181,067	8,181,067	8,181,067								
Elevated extensions	5,161,567	a10,696	5,150,871			10,696	5,150,871	5,150,871	5,150,871								
Undistributed costs	691,805	.. ..	691,805			. .	691,805	691,805	691,805								
Total N. Y. Municipal Railway Corp	73,022,578	a1,330,535	73,692,043		78,650,984	1,330,535	73,692,043	73,692,043	73,692,043								[illegible]
Grand total, B. R. T. System	171,713,527	17,101,850	154,608,677	g232,175,074	247,991,278	34,551,110	137,162,417	141,498,681	189,929,505								[illegible]
Interborough Rapid Transit System																	
(1) Contracts 1 and 2 Subway	43,898,479	a7,887,251	36,011,228		57,204,246	7,887,251	36,011,228	36,011,228	36,011,228	These details are not furnished [illegible] operated under contract [illegible]							
Contract 3 Subway	101,483,864	a1,825,537	99,658,327		108,173,910	1,825,537	99,658,327	99,658,327	99,658,327								
Total I. R. T. Subway lines	145,382,343	a9,712,788	135,669,555		165,678,155	9,712,788	135,669,555	135,669,555	135,669,555								
(2) I. R. T. Elevated lines—																	
Additional tracks	21,239,406	a35,617	21,203,789	235,250,100	21,380,608	35,617	21,203,769	21,203,789	21,203,789								
Elevated extensions	12,963,265	a509,430	12,453,835		13,082,836	509,430	12,453,835	12,453,835	12,453,835								
Manhattan power plant improvement	5,642,679	a1,011,297	4,631,382	h	5,633,130	1,011,297	4,631,382	4,631,382	4,631,382								
Additions to Manhattan RR	264,627	a2,132	262,495		264,628	2,132	262,495	262,495	262,495								
Total I. R. T. elevated	40,109,977	a1,558,476	38,551,501		40,367,222	1,558,476	38,551,501	38,551,501	38,551,501								
(3) Manhattan Ry Co (original elevated)	62,417,138	5,042,933	57,374,205	105,199,139	113,001,111	19,123,729	43,293,409	41,924,656	63,805,230	24,815,733	4,106,182	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Grand total I. R. T. System, sub & elev lines	247,909,458	16,314,197	231,595,261	340,449,839	319,046,792	30,394,993	217,514,465	216,145,712	238,026,346								
New York Railways System—																	
New York Railways Co (owned)	b35,068,875	4,382,000	-	..	76,266,488	......	......	....	...								
New York Railways Co. (leased)	.....	4,603,251	......	..	9,852,557	......	......	..	.....								
Total	35,068,875	c12,401,773	22,667,102	190,380,445	107,119,045	9,246,206	25,822,718	28,313,319	48,175,800	23,858,457	[illegible]	7,847,100	[illegible]	[illegible]	[illegible]		[illegible]
Eighth Avenue RR	3,910,766	1,105,843	2,804,923	1,636,200	6,475,762	962,800	2,917,969	3,526,819	6,060,327	3,744,195	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
Ninth Avenue RR	2,373,571	197,365	2,176,205	800,000	3,171,331	756,100	1,617,161	1,829,055	3,840,285	3,025,208	[illegible]	[illegible]	[illegible]	[illegible]			
New York & Harlem RR	3,695,499	1,471,945	2,223,554	j2,8[illegible]	j 2,317,468	1,115,100	2,580,325	3,253,756	6,[illegible]8,212	4,318,557	[illegible]	[illegible]	[illegible]	[illegible]			
Total system	45,048,711	15,176,926	29,871,785	95,667,189	119,083,606	12,080,200	32,968,506	36,952,949	64,674,624	34,946,797	2,583,336	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
Third Avenue Railway System—																	
Third Avenue Railway Co	20,100,654	2,362,223	17,738,431		31,887,094	6,317,558	13,783,096	15,324,972	27,500,230	12,258,081	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
Kingsbridge Railway Co	1,060,305	26,500	1,033,805		2,276,168	295,305	765,000	845,341	1,716,0[illegible]	1,427,844	[illegible]	.	[illegible]				-
Third Avenue Bridge Co.					113,109												
Belt Line Railway Corporation	1,831,559	81,978	1,749,581		1,965,270	377,090	1,451,469	1,770,130	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]
Dry Dock East Broadway & Battery RR	1,966,279	242,250	1,724,029		4,343,091	628,958	1,337,321	1,640,839	3,117,307	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]
42d St Manhattanville & St Nicholas Ave Ry	2,988,132	429,633	2,558,499		12,573,533	874,109	2,114,023	2,602,428	5,162,926	[illegible]	212,812	[illegible]	[illegible]				[illegible]
New York City Interborough Railway Co	1,954,093	216,359	1,737,731		7,049,124	851,988	1,102,105	1,222,518	2,444,247	[illegible]	[illegible]	[illegible]	[illegible]				
Southern Boulevard Railroad Co	428,097	16,800	411,297		707,233	218,021	210,076	270,431	488,064	[illegible]	[illegible]		[illegible]				-
Union Railway Co	6,874,577	599,263	6,275,314		9,840,898	2,747,943	4,126,634	4,931,400	8,872,666	[illegible]	[illegible]	1,027,400	[illegible]	[illegible]	[illegible]		[illegible]
Bronx Traction Co	854,044	31,200	822,841		702,859	317,991	536,053	632,097	1,158,729	946,273	66,346	.	[illegible]				
Mid-Crosstown Railway	185,446	366,700	def 181,254		161,063	66,519	118,927	143,582	271,734	238,118		.	33,610				
Pelham Park & City Island Ry	101,650	4,500	97,150		82,790	31,112	70,538	72,436	129,443	113,323		.	[illegible]	. .			
Total Third Avenue Railway system	38,344,838	4,377,406	33,967,430	k68,599,961	74,702,242	12,726,591	25,618,242	29,456,174	53,817,386	30,419,454	4,201,471	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
Second Avenue Railroad Co.	5,320,882	522,565	4,798,317	l10,722,000	e8,308,413	1,583,602	3,737,280	4,539,165	8,805,364	6,589,337	72,262	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
p Staten Island Companies	4,817,658	601,915	4,215,713	m3,855,517	j5,702,670	1,598,335	3,219,323	3,507,445	5,402,727	2,403,341	1,393,334	[illegible]	217,520	[illegible]	[illegible]	9,000	[illegible]
Queens Borough Companies—																	
New York & Queens County Railway	4,739,055	781,673	3,957,382	6,235,000	8,922,229	1,920,771	2,818,284	3,109,033	5,792,197	3,616,085	491,634	1,117,000	235,200	[illegible]	[illegible]	[illegible]	188,610
Long Island Electric Railway	725,209	213,531	511,678	1,200,000	1,617,590	316,691	408,518	523,756	967,075	676,305	81,566	127,100	[illegible]	[illegible]	[illegible]	8,000	[illegible]
New York & Long Island Traction Co.	619,946	163,425	456,571	2,000,000	2,472,804	228,505	391,491	446,765	805,504	324,757	31,918	335,200	[illegible]	[illegible]	[illegible]	20,000	[illegible]
Ocean Electric Railway Co.	372,270	103,300	268,970	354,289	512,061	168,750	203,520	214,614	421,579	237,731	[illegible]	[illegible]	[illegible]	-	- -	- -	------
Manhattan & Queens Traction Corp	1,125,824	239,831	885,993	n1,431,617	690,693	380,935	744,899	737,026	1,418,021	861,743	40,156	440,000	[illegible]	[illegible]	-	- -	------
New York & North Shore Traction Co	171,382	126,212	45,170	o1,753,850	1,642,380	39,200	132,182	167,482	270,882	-----	.	197,800	8,900	39,182		[illegible]	[illegible]
Total Queens Borough companies	7,753,736	1,627,972	6,125,764	12,974,786	15,857,737	3,054,852	4,698,894	5,198,676	9,676,258	5,716,627	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
q Miscellaneous Companies	572,483	75,276	497,207	650,000	758,061	131,165	441,018	425,511	716,061	365,340	[illegible]	197,500	[illegible]	[illegible]	[illegible]		- - -
Grand total—all companies	521,181,291	d55,801,137	465,680,154	765,091,366	791,450,841	96,121,151	425,360,145	437,724,313	571,018,271								[illegible]
City's Investment—Subways—																	
Contracts 1 and 2 (I. R. T.)	62,767,713	a91,657	62,676,056	.	....	91,657	62,676,056	62,676,056	62,676,056	See notes opposite B. R. T. and I. R. T. [illegible]							---
Contract 3 (I. R. T.)	88,086,508	a27,517	88,058,991		....	27,517	88,058,991	88,058,991	88,058,991								---
Contract 4 (B. R. T.)	142,801,094	a42,902	142,758,192		.....	42,902	142,758,192	142,758,192	142,758,192								-
Total—City	293,655,315	a162,076	293,493,239	.... .	.	162,076	293,493,239	293,493,239	293,493,239								--- --
Combined total—companies and city	815,136,606	c55,963,213	759,173,393	......	.. ..	96,283,227	718,853,384	731,217,552	864,541,510								13,259,920

Footnotes: (a) Represents accrued depreciation. (b) Not separately computed. (c) Includes $20,970 electrical and mechanical equipment and $[illegible],540 rolling stock not distributed among the various companies in the New York Railways System. (d) Accrued depreciation, company investment, $12,601,799; expenditures necessary to place property in first-class condition, $43,199,338, total, $55,801,137. (e) Accrued depreciation, company investment $12,601,799, accrued depreciation, city investment, $162,076, expenditures necessary to place property in first-class operating condition, $43,199,338, total, $55,963,213. (f) Includes capital stock, bonded debt, certificates of indebtedness, receivers' certificates and construction advances. (g) Excludes bonds, $103,106,316, stocks $39,325,632, certificates and construction advances $42,279,388, held among system companies. (h) Excludes acquired bonds, $[illegible]. (i) Excludes securities of subsidiary companies held by N. Y. Rys Co., viz.: Stocks, $7,161,300, and bonds, $3,151,342. (j) Includes arbitrary apportionment of $[illegible] to street railway division of Rich. Lt. & R. R. Co. as made by State Tax Commission. (k) Excludes securities of subsidiary companies held by 3d Ave Ry. Co., viz.: Stock, $[illegible]; bonds, $[illegible]; construction advances $14,511,785. (l) Combining reports of receiver and company and including adjustments conforming with U. S. Circuit Court decisions. (m) Includes [illegible] notes $[illegible] as per report of Rich. Lt. & R. R. Co. (n) Includes receivers' certificates, $4,500, shown in annual report. (o) Excludes lighting department fixed capital and materials and supplies $3,776,493.06, and eliminates bonds and stocks in similar total amount. (p) Staten Island Cos. include Richmond Lt. & R. R. Co., Southfield Beach R. R. and Staten Island Midland R. R. (q) Miscellaneous companies include Manhattan Bridge 3-ct. Line and Van Brunt St. & Erie Basin R. R. (r) The non-operating properties (last column to right) aggregate on original cost basis $13,259,920, viz.: (1) Track and structures, $4,239,309; (2) electrical power and mechanical equipment $1,014,236; (3) land (1921 value), $7,618,587; incidental $[illegible]. On basis of 1921 prices with land again taken at $7,618,587, they aggregate $122,029,738. (s) These items include expenses during and prior to construction, including interest on expenditures, engineering, administrative and legal outlay, brokerage fees for marketing securities, etc.

For the purpose of producing or reproducing the properties as existent today, it was assumed that the company would contract for the work to be performed on the basis of their system on a [illegible] program retaining the [illegible] of these lines [illegible] construction.

In estimating the unit costs, due consideration was given to the local conditions entering into the construction per lineal foot of railroad and to the experiences of some work conducted in the city streets and to unusual difficulties connected with the construction of the structure, which would be factors in the cost of the [illegible].

Overhead Charges. During the development and construction of the railroad the company is obliged to defray the attendant expenses for legal services, executives, administrative and office [illegible], engineering, [illegible] and insurance, interest on expenditures, brokerage fees of securing funds and taxes on property as levied by the municipality. These charges have been segregated into "Expenses during Development" and "Expenses during Construction."

Interest on expenditures during construction was allowed at 5% for the estimate of original cost and 6% for reproduction cost for [illegible] to 1914 and at 7% for reproduction cost in 1921 so as to conform with rates existing at the periods specified.

Brokerage fees consisting of the expense for marketing securities were allowed at 3½% in the estimate for original cost which rate was derived from an estimate of the actual expense for such services. A rate of 5% was allowed for each of the two estimates of cost to reproduce. No consideration was given to bond discount or premium which it was held should not be treated as capital items.

Track and Structures.—The appraisal is based on measured or computed quantities entering into each item of this group with the costs applied thereto.

Rolling Stock. The valuation is based on the result of a field inspection to determine the actual number of cars and their type and the prices applied are based on the actual or estimated cost to the company ready for operation.

Land. The land owned in fee by each company has been allowed at its market value as of June 30, 1921, determined by expert real estate appraisers. This market value was held to apply to both the original cost and the Costs to Reproduce. It was felt that the companies were entitled to credit for land at its market value because of its availability for sale for other than railroad purposes.

Easements, Private Right of Way, Consents and Damages.—For each of these items, it was held that allowances should be limited to the actual expenditures by the company and the same amount is included for the costs to reproduce as in the original cost estimate.

Depreciation on "Straight Line" Method.—Where it is held that depreciation should rationally apply in the appraisal of a public utility company, the straight line basis has been employed in this report as the most practical means of determining the amount which should be deducted from the value of the property to which depreciation applies. This method consists in ascribing an estimated life to each class of property and computing depreciation on its cost or valuation on the basis of its age on the date of the appraisal for each of the transit companies or system.

For the property included under the Dual Contracts and their Related Certificates, the depreciation has been computed on the basis of the report of the former Transit Construction Commissioner, addressed to the interested companies, in which rates of depreciation have been specified for each class of property. These rates have been applied to the cost of the property from the date it was placed in operation. These rates, however, have not as yet been formally accepted by the companies.

Expenditures Necessary to Place Property in First-Class Operating Condition.

For the purpose of determining the actual conditions, a field inspection was made of each class of property to provide data for an estimate of the expenditures necessary to place the property in first class operating condition. The estimate was made as of June 30, 1921, and is not necessarily the present day condition, particularly in respect to rolling stock.

To correct deficiencies, there has been included in the estimates of the necessary expenditures not only an amount to correct deferred maintenance and repair, but also an allowance for renewals and replacements of equipment which because of age and general condition should be retired from service.

It is believed that due consideration should be given to an estimate of the necessary expenditure of this character as a practical means of determining the actual rather than the theoretical depreciation. Renewals and rehabilitation from time to time will [illegible] and if successively continued may [illegible] to an extent difficult to estimate. The [illegible] would then become the determining factor in the [illegible] of [illegible] classes of railroad property.

Conclusions and Recommendations.

After a full consideration of all the facts it is our conclusion that a fair valuation for the existing property of companies other than that [illegible] under Contracts 1, 2, 3 and 4 and their Related Certificates would [illegible] in allowing the original cost less the expenditures necessary to put the property in first class operating condition.

Valuation of the property paid for by the Interborough Rapid Transit Co. as included under Contract 3 and similarly that paid for by the New York Municipal Railway Corporation under Contract 4 and also the property included under the certificates for extensions, additions, third-tracking and reconstruction of the elevated structures, which accompany Contracts 3 and 4 should be based on the determination of cost by the Chief Engineer of the Commission, as provided in such contracts, with the deduction therefrom of the accrued depreciation also therein provided for. The property provided under Contracts 1 and 2 by the Interborough Rapid Transit Co. has also been appraised on this same basis.

It is our opinion that the cost so determined based on accurate cost data, represents the fair reproduction cost referred to in the Transit Act.

It is our opinion that there should be included in such valuation only the property now existent and suited for operation.

Land, buildings, power plants, or other equipment not used or useful for operation should be excluded from the valuation and deemed to be assets of the company to be disposed of as it sees fit.

No track or roadway which has been abandoned and allowed to disintegrate so as not to be suitable for operation should be included in the valuation.

It must be realized that the valuations are of the property as of June 30, 1921, and that the results should ultimately be brought to the date of any contemplated settlement so as to adjust for retirements, additions, flucturations in value, etc.

While all valuations as herewith presented are based on the inventory of property as of June 30, 1921, which was deemed to be used or useful for the operation of the railroads or systems as then constituted or as then capable of being operated.

It is not within the purview of this report to segregate or discard in whole or in part any property of any company which might be designated as not necessary or needful in any plan developed for the revamping of the transit facilities so as to effect an economic unification of the present systems.

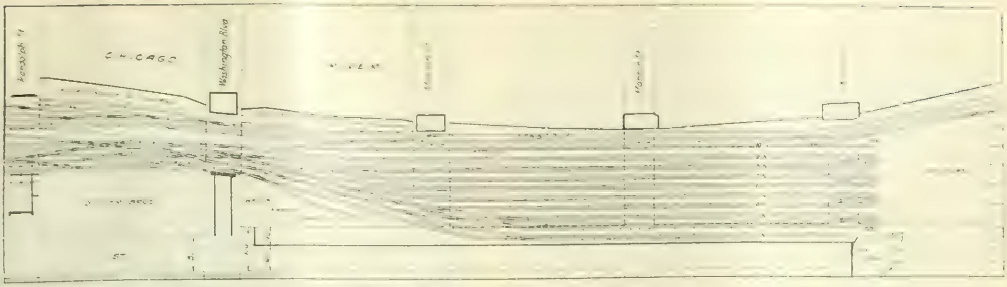
The final statutory plan of the Commission is expected to embrace only such property as is to be acquired for such a unified system of transit and the valuations herewith will permit of the schedule to be prepared of the properties on any premises as therein adopted.

Track and Platform Features for the New Chicago Union Station

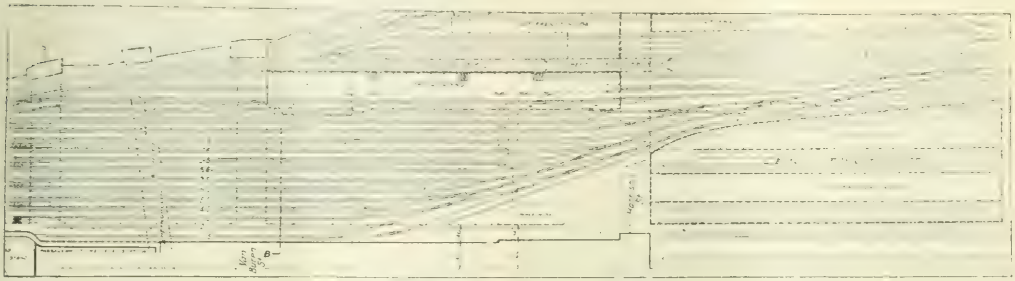
Space limitations and the requirements of the various roads using the property lead to the adoption of a double stub end track arrangement for the union passenger terminal now under construction at Chicago. The arrangement is shown in the accompanying illustration, the scale of which may be judged approximately from the fact that the block between Adams and Monroe streets is about 400 ft. long between property lines. The property is owned and used by the Pennsylvania; Chicago, Burlington and Quincy; and Chicago, Milwaukee and St. Paul roads and some of their subsidiaries; and is used by the Chicago and Alton under a lease.

The station handles a mixture of suburban and main line traffic, and the capacity of the new tracks will be about 50 per cent in excess of total present requirements. The shorter tracks will be used by the suburban trains. Two through freight tracks and one through passenger track are provided at the east side of the station near the river as shown, and at a different elevation from the stub end passenger tracks. Electrification is provided for by maintaining a 17 ft. minimum clearance throughout the station; but the plans call for its opening under steam traction, with no definite time set for the change to electricity.

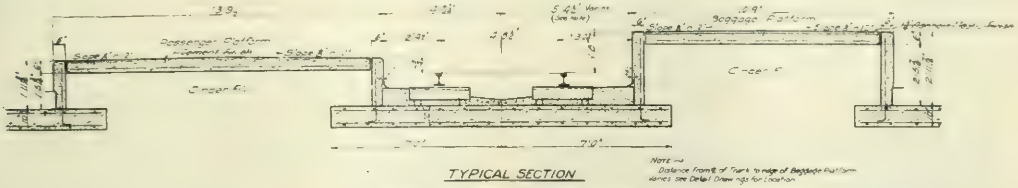
Station track rails are of 100 lb. and approach rails of 130 lb. Pennsylvania section. No. 9 turnouts are used at the south approach. Elsewhere throughout the station, No. 8 turnouts and slips are used. All tracks and special work in the station are laid on a 10 in. slab of 1:2:4 reinforced concrete. The rails are carried on 6 in. x 8 in. x 2 ft. 6 in. creosoted pine blocks, 20 to a 33 ft. rail. At rail joints the blocks are spaced 17 in. on centers. They are partially embedded in concrete as shown. Drainage between the rails is on grades of about 0.4 per cent corresponding with the track grades, which are nowhere perfectly level. Inlets are spaced about 85 ft. apart on laterals of 8 in. cast iron pipe which lead to 12 in. cast iron mains on either side. The mains lead to a sump, from which the water is pumped to the river.



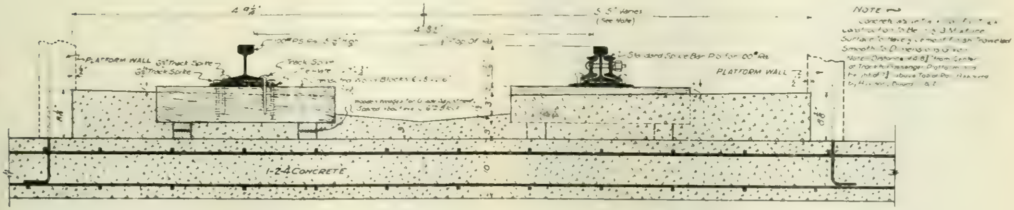
Station Tracks and Connections North.



Station Tracks and Connections South.


Passenger Platform
Cement Finish
Baggage Platform
Cinder Fill
TYPICAL SECTION
NOTE —
Distance from ℄ of Track to edge of Baggage Platform varies. See Detail Drawings for Location

Typical Track and Platform Section.



Detail of Track Section.

The platform arrangement is most interesting, and involves several important changes from the plans as originally made several years ago. As now planned the platforms will alternate between exclusive baggage and exclusive passenger use, each track lying between platforms of the two different kinds. The arrangement and dimensions appear in the accompanying section.

Low platforms were decided upon because of the variety of cars—many of them from connecting lines which normally enter the station. Passenger platforms are to be 7¾ in. and baggage platforms 1 ft. 8 in. above top of rail. They are designed for conversion to the high type whenever car equipment shall be sufficiently standardized to warrant the change. For this reason the original construction will place them slightly below the level of the concourse floor. Inclines from the passenger platforms will lead up directly to the concourse, while the baggage platforms will terminate in ramps leading to the baggage room below. This arrangement is considered as saving trucking, as well as much tunnel and elevator construction which otherwise would be necessary and very expensive because largely below the river level. The ramps will be 10 ft. 4 in. wide to provide for 2 trucks abreast.

Not only are the main station features below street levels, but some of the tracks are as much as 3 ft. below.

The waiting room floor will be 16½ ft. below Canal St. river level. Persons familiar with the present union station and the very awkward grades along its Canal St. side will be pleased to know that the new plans provide for the complete rectification of these defects.

The concourse extends under Canal St. to its connection with the main waiting room, which occupies a space of 100 ft. by 250 ft. in the center of the head house. The head house will occupy the entire block bounded by Canal, Madison and Clinton streets and Jackson Boulevard. It will be an office type of structure, only the lower portion being used for railway purposes. The very important mail terminal building, now nearing completion, occupies a strip 75 ft. 6 in. wide between Harrison and Van Buren streets, and adjoining the through tracks already mentioned. Its length is 796 ft. This building is connected with the baggage room by a tunnel, and with the same [illegible] trusses covered by tunnel and elevators in the baggage platforms.

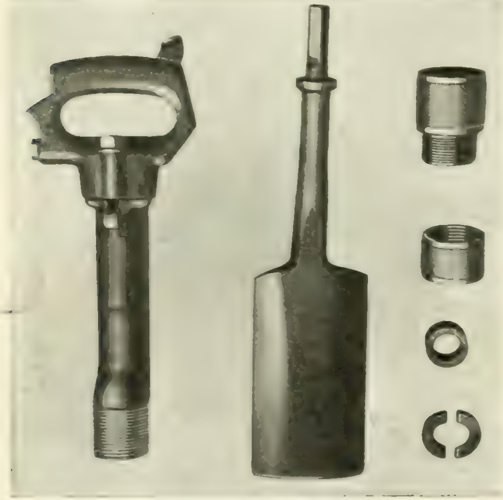
Train sheds will be of a modified Bush type, the supporting columns all being located on the passenger platforms, thus leaving the baggage platforms entirely clear.

Work on this station project was interrupted by the war, and later by other circumstances. New considerations brought out during the period of inactivity lead to several important changes, among which was the substitution of an office structure for a joint railway head house, the inclusion of the railway mail terminal and the establishment of separate passenger and baggage platforms at low instead of high level design. Not the least of the problems involved was the providing of suitably located sites to which to remove certain yards which occupied ground necessary to the project.

Engineering and Contracting is indebted for the above information and illustrations to Mr. J. D'Esposito, Chief Engineer, and Mr. Clarence J. Noland, Assistant Engineer in charge of [illegible].

Compressed Air Spader for Clay Digging.

A hammer-like digging tool designed particularly for excavating stiff clay in trenches, open pits and tunnels in which the ground is not sufficiently hard to be drilled and shot and yet too hard to be handled readily by the ordinary pick and shovel method, has been placed on the market by Sullivan Machinery Co., Chicago. This tool consists of a light Sullivan air hammer, weighing only 20 lb. with a length of 17 in. and requiring ½ in. air hose, equipped with a steel spade and special retaining ring or bushing. The bushing and spade are of the Bronson pattern. In tunneling in blue glacial clay, very hard and dry, in the Chicago district, compressed air spaders are stated to have increased the output per miner from 3 to 4 cu. yd. per 8-hour shift, to from 8 to 10 cu. yd., and the limit of work accomplished was governed by the ability to get rid of the muck instead of by the rate of digging, as formerly. As will be noted from the illustration the Sullivan spader consists of a cylinder provided at the rear end with a handle secured to it by side rods, and at the other with a special retainer for holding the steel spade in the nose or chuck of the hammer. A hollow, cylindrical or shell valve is employed, operated by differential pressure. The hammer or piston runs up inside the valve itself, thus providing a long stroke without excessive length of tool, or undue waste. The drill is operated by pressure on a trigger or thumb throttle placed at the top of the handle grip, where its action will not be hindered by an accumulation of mud or grit. The spader strikes a hard, snappy blow, giving abundant power for the work to be done and satisfactory work can be accomplished at any air pressure from 45 lb. to 100 lb., although the higher range of pressure is strongly recommended, particularly for stiff ground.



Hammer, Spade and Retainer of Sullivan Spader

Self Cleaning Shovel Dipper.

A dipper having several new features has been placed on the market by the Bay City Dredge Works, Bay City, Mich. In dumping this dipper tips forward thus assuring, it is stated, a clean dump. This dipper was patented by Michael J. Zatawa, and has been in service since the spring of 1918, on his dredge and others in Minnesota and Wisconsin. It will be known as the Bay City Type Z shovel dipper. It will be manufactured for capacities ranging from ½ to 2 cu. yd. Although it will be used as standard equipment on Bay City land dredges, it is also designed for floating dredges and for steam shovels.

Bay City Type Z Shovel Dipper.

A New Gasoline Powered Lift Truck

A gasoline powered elevating platform truck embodying many new construction features has been put in production by the Clark Tructractor Co., Buchanan, Mich., manufacturers of gasoline driven industrial trucks and tractors. This machine, which will be known as the Clark Truklift, conforms in appearance and uses to the electric elevating lift trucks which have been used in industrial plants for many years. Low initial cost, ease of maintenance, flexibility and continuous 24-hour service are distinguishing characteristics claimed for it by the builders. The loading platform is 26 in. wide x 54 in. long and will elevate its load of 4,000 lb. from a minimum of 11 in. to a maximum of 16 in. from the floor in eight seconds; automatic stops provide for both up and down limits; elevation can be stopped by hand control lever at any point. The lifting mechanism is operated by hydraulic pressure. Power for locomotion and elevating the load is derived from a 15 H.P. 4-cylinder tractor engine with a 3½ in. bore and 4½ in. stroke. The engine is mounted at the rear in a closed compartment containing transmission, governor, vacuum tank, radiator, etc. A three-point suspension is used; the steering wheel forks being supported in a steel casting which is pivoted at the center of the frame on a chrome nickel steel pin 2 in. in diameter. The drive is through a Clark bevel gear axle equipped with ball and roller bearings located under the loading platform. Driving wheels are cast steed with pressed on rubber tires 10½ in. x 5 in.; steering wheels are cast steel disc type with pressed on rubber tires 16 in. x 3½ in. Standard automotive construction has been adhered to wherever possible so that the truklift can be serviced by any good automobile or truck mechanic. A hinged hood renders the engine available for inspection instantly and, if necessary, the machine can be stripped down to the chassis in less than twenty minutes. The driving and elevating controls are mounted on the rear of the engine compartment and are operated by the driver who drives standing. The brake lever pedal is under the driver's foot and so arranged that the truklift stops automatically if for any reason the operator steps off while the machine is running.

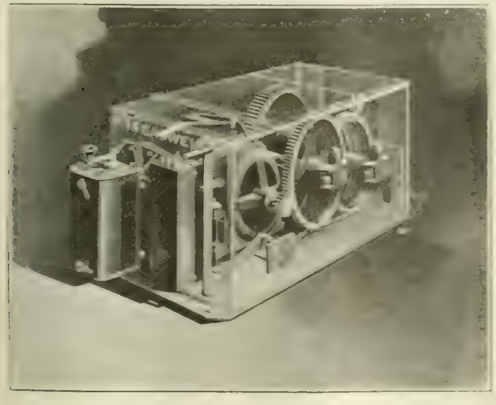
The truklift is the outgrowth of two years of development and testing work and is intended to meet the needs of those who require a full powered machine to work eight hours or more a day continuously in the transporting of materials in departmental or inter-plant haulage. It will climb a 10 per cent grade with a 4,000 lb. load and has two speeds in each direction. The total weight of the truck ready to go to

New Clark Gasoline Powered Lift Truck

work is 2,500 lb.; over all length of machine is 107 in.; width, 35½ in., and height, 51 in.

New Hoist Is Wholly Enclosed

A self-contained, small portable hoist having several novel features has been developed by the Treadwell Engineering Co. at Easton, Pa. It is designed with the idea of providing a machine for light hoisting and hauling, which should be mechanically dependable and both safe from injury to its mechanism and safe against injuring a heedless workman. This hoist is wholly enclosed in a heavy sheet steel plate casing, mounted on a ½ in. steel sole plate. The unit casting forms the support for the drum and gear shaft bearings, which latter are electric steel castings, fitted with renewable bronze bushings and lubricated from a waste packed oil reservoir. The controller box and resistance panel are of necessity mounted on the exterior of the casing. All other mechanism and the motor are entirely enclosed. The hoist is provided with a clutch manipulated by a lever at the operator's end of the hoist, which lever is automatically locked either "in" or "out." Control of the load is effected by a powerful band brake whose controlling hand-lever is very conveniently placed. This brake lever is normally latched in an "off" position, allowing the hoist drum to run free. A removable door or cover is provided on the top of the casing to give easy access to the mechanism within. All parts, except the barrel of the rope drum, are made of steel.



New Treadwell Hoist.

The 8x12 in. drum has a capacity of 1,5[illegible] [illegible] of ¾ in. wire rope and the rated hoisting capacity of 1,500 lb. at a speed of 100 ft. per minute. The standard motor employed is of 5 H.P., operating at 1,200 r.p.m. The entire hoist measures 2 ft. x 2 ft. x 4 ft. 5 in. over all.

News Letter

ST. LOUIS ITEMS.

By A. B. Koenig

R. G. Hill & Co., Knoxville, Tenn. [illegible] Memphis, Tenn.

[illegible] Smith & Co. have their [illegible] R. R. [illegible] in full [illegible] contract [illegible]

[illegible] & Sons [illegible] Central R. R. [illegible]

[illegible] Wainwright [illegible] St. Marys, Mo. [illegible] yards [illegible]

Al [illegible] Santa Fe R. R. [illegible] Scott & White [illegible] job [illegible] Southern [illegible]

Will [illegible] Kansas, will [illegible]

Frank [illegible] Kansas City [illegible] Frank reports a [illegible]

Contractors [illegible] Labor Agency, [illegible] Walnut St., St. Louis, [illegible]

[illegible] F. [illegible]

The contract for the new Frisco [illegible] Springfield, Mo., was awarded to the William [illegible] Construction Co. of St. Louis on a bid of [illegible]

A. [illegible] M. K. & T. R. R. near St. Charles, Mo. Is also [illegible] Kan.

[illegible]

[illegible] & [illegible] were awarded [illegible]

[illegible] Texas [illegible] railroad work in Arkansas or Texas.

The Cox Construction Co. [illegible] Frisco R. R. work. John [illegible] Highlands, while Chas. [illegible] in charge of the work near Crocker, Mo.

W. P. [illegible] and W. M. K[illegible] of [illegible] Smith & Co. [illegible] North.

Keating Bros. have their [illegible] at Woodlawn, Ill.

The [illegible] Track Const. Co. are [illegible] the Wabash R. R. west of the city.

Scott & White started a track gang on the Frisco R. R. near Paola, Kan.

[illegible] Manhattan Ave., [illegible] N. Y. [illegible] steam shovel [illegible] Wants a job or will [illegible] material by the yard.

[illegible] Bros. [illegible] S. [illegible] Springfield [illegible] their work there. [illegible] Wheeler and Fresno [illegible]

[illegible] Wheeler [illegible]

[illegible] Would like to [illegible]

[illegible] W. [illegible] were awarded contract for grading and [illegible] Burlington R. R. between [illegible] Walshville, Ill. The [illegible] going to have their headquarters at Sorento. Will sub-let half of this work.

[illegible] St. Paul [illegible] Burlington R. R. between [illegible] and Waltonville, Ill. [illegible] work.

The [illegible] Co. were awarded contract for grade reduction [illegible] Central R. R. [illegible] yards [illegible] shovels [illegible]

Street [illegible] Board of Public Service [illegible]

[illegible] W[illegible] Central R. R. at Bradley [illegible]

[illegible] Mo. [illegible]

[illegible] & S[illegible]e Co., Federal Reserve Bank Bldg., St. Louis, Mo. [illegible]

W. H. [illegible] immediately.

[illegible] & [illegible] while [illegible]

[illegible] Memphis [illegible] Frisco R. R. [illegible]

[illegible] Bluff, Ark., was [illegible] Little Rock [illegible] The specifications [illegible]

The Missouri Pacific R. R. Co. [illegible] April 8 for [illegible] bridges on the White River [illegible] between [illegible] Mo., and Reed Springs, Mo. Up to the present writing work has not been awarded.

[illegible] of Yale & Reagan, expect to leave soon for Westfield, Mass., to begin operations on their [illegible] at that point.

Contractors wishing [illegible] work [illegible] write [illegible] Walnut St. [illegible] Mo., or 507 Delaware St., Kansas City, Mo.

Smith & White have [illegible] of track work on the Santa Fe R. R. between Satanta and the Colorado state line. [illegible] sub-contractors on this work: W. A. Colt & Son [illegible] work; G. L. [illegible] miles; Gilliland [illegible] Thompson Bros. [illegible] miles; C. L. [illegible] Gibson & Stone, 3 miles; Frank Barlow, 4 miles. Expect to begin track laying about the 1st of May.

[illegible] C. [illegible] is with W. F. [illegible] the field offices of [illegible] Smith & Co.

Sawyer & Oliver Const. Co. [illegible] Lacoste Bldg., have [illegible] bids on state road work near [illegible] Mo. [illegible]

Plans for the immediate erection of a new electric generating plant at Cahokia, Ill., at a cost of $[illegible] and the construction of a transmission system at a cost of $[illegible] the power [illegible] St. Louis were [illegible] by the Union Electric Light & Power Co. of St. Louis through its president [illegible] H. [illegible] as the first step in a program of construction calling for the expenditure of $[illegible]

[illegible] & [illegible] of [illegible] Mo., [illegible] secured the contract for building the bridge across the White River near Reed Springs [illegible] on a bid of $[illegible]. The contract to repair the [illegible] to the bridge from both sides was awarded to Oberlander Bros. of Nixa, Mo., on their bid of $[illegible]. Work will be started about the first of May.

Announcement has been made that the Missouri Pacific R. R. is contemplating the erection of a new depot at Washington, Mo., to cost $[illegible]. The new depot is the first on the company's building program for this year.

The L[illegible] Construction Co. was awarded contract for putting in a water system at Gillespie, Ill., for $[illegible]. The new system will get its supply from reservoir.

The contract for constructing 16 miles of improved roads in Poinsett County, Arkansas, was awarded by the commissioners of the Bay and St. Francis River Highway Improvements District to L. D. Harvey & Co. of Memphis, whose bid was $[illegible]. The district to furnish materials.

Construction gangs of the Wabash Railroad Company will begin in a few days the work of laying new 90-lb. rails on the Springfield division between Wyckles and Harristown, a distance of [illegible] miles. The work will start at the east end of the yards at Wyckles, a town 3 miles east of Decatur, Ill. New rails were laid last year from Mercer street, Decatur, to the Wyckles yards. The new track equipment to be installed will include rails, switch stands and frogs. Whether or not the company will lay new rails [illegible] Springfield and also on the Hannibal division has not been [illegible] by railroad officials. Plans are under way for considerable bridge construction work during the summer months. In some places according to present plans, new structures will be [illegible], while in other places only necessary repairing and repainting will be done.

John E. Bretz was awarded the contract for paving North Sixth street from Madison street to North Grand avenue in Springfield, Ill., at a special meeting of the City Council held March 15. His bid for paving was $[illegible] a square yard.

The John T. Walbridge Construction Co. of Chicago have started work on their sewer job in Springfield, Ill., and expect to complete work within less than a year. A bond issue of $[illegible],000 was voted to defray the expenses of this improvement.

The initial step in the plan to give Calhoun County, Ill., an outlet by rail was taken when the Chicago & Alton Railroad led an application to extend its line to a point on the Illinois River opposite Hardin, the county seat of Calhoun County. If the commission acts favorably on the application the Alton will extend its [illegible]-Titus branch from Titus southwest 3¼ miles into the Nutwood drainage district to what is known as Reddish road. From a point on this extension 2 miles south of Titus the company will construct a branch to a point on the Illinois River opposite Hardin. This branch will be 1¾ miles long. Ferries will connect Hardin with the rail terminal across the river. At this time there is not a foot of rail in Calhoun County, but with the Alton extension reaching to a point across the river the residents eventually expect to see a bridge constructed.

A. E. [illegible], president of the Murphysboro & Southern Railroad Company, announced that subscriptions to the preferred stock of the company will justify the extension of the interurban line from [illegible] to [illegible], Illinois, and work will begin May 1. Citizens of [illegible] and the Murphysboro's [illegible] and Carbondale's [illegible] have been nearly subscribed. The company will raise the balance of the finances needed.

A contract has been awarded for the [illegible] of a section of the [illegible] road in Carter County, Missouri, [illegible] miles along Carter [illegible] Hunter, to the Davis Construction Co. of [illegible]. The amount of their bid was $[illegible]. Work [illegible] this road will start immediately.

The State Highway Commission at Nashville, Tenn., awarded the contract for the [illegible] of [illegible] of road in Carroll County to [illegible] contractors of Memphis, Tenn. The [illegible] lowest of 29 con[illegible] for the work. The contract for the building [illegible] in Marion County was awarded to Estes, Wil[illegible] & [illegible] Company [illegible]. The bid was [illegible].

[illegible] Camden, Mo.

The [illegible] Pacific R. R. [illegible] bids for the construction of a [illegible] at H[illegible]

[illegible] for the bridge [illegible] R. R. [illegible] the work immediately. [illegible] Company at [illegible] will begin [illegible] Commissioner of [illegible] St. Louis [illegible] consulting engineer and [illegible]

Personals

Walfred Fregolle has been appointed village engineer of Hibbing, Minn.

George C. Stanley has been reappointed city engineer of Burlington, Vt.

J. H. Kennedy has been reappointed superintendent of waterworks of St. Albans, Vt.

L. A. Grimes has been appointed superintendent of waterworks and sewers of Abilene, Tex.

Henry A. Fulenwiter of Wilmington, Del., has been appointed town engineer of New Castle, Del.

Capt. Fred W. Lang, assistant city engineer of Concord, N. H., has been appointed city engineer to succeed Will B. Howe, who died April 3.

R. C. Miller, division engineer of the Chicago terminal division of the Northwestern region, Pennsylvania System, has been transferred to Harrisburg, Pa.

C. S. McConnell has been appointed roadmaster of the Chicago & Northwestern Ry. at Antigo, Wis., succeeding M. S. Hatless, who has been retired on pension.

W. T. Pierce and I. T. Winsett of Tucson, Ariz., have organized the Pierce Engineering Co. of Tucson and will engage in a general engineering and construction business.

E. L. Hoopes, supervisor of the eastern division of the Pennsylvania System with headquarters at Huntingdon, Pa., has been promoted to division engineer with headquarters at Grand Rapids, Mich.

Robert Whitten has opened offices at 1614 Prospect Ave., Cleveland, O., for professional practice in general city planning and city zoning. He will be associated with A. D. Taylor, landscape architect and town planner.

William H. Butts, for 26 years a professor of mathematics in the College of Engineering and for the last 14 years assistant dean of that college at the University of Michigan, will retire at the end of the present college year.

George H. Rowe, for the past year an assistant engineer of the Board of Public Utilities of Los Angeles, Calif., assigned to telephone work, has resigned to accept a similar position with the California State Railroad Commission.

Herbert A. Wilson, Building Commissioner of the city of Boston, Mass., has been appointed police commissioner of the city at a salary of $8,000 a year. Mr. Wilson is a civil engineer and formerly was an assistant engineer in the Department of Public Works of Boston.

Col. Thomas F. Sullivan, formerly commissioner of public works of Boston, Mass., has been appointed chairman of the Transit Department Commission of that city. Louis K. Rourke, also a former commissioner of public works, has been appointed a member of the commission.

T. J. Irving has been appointed division engineer of the Minnesota Division of the Chicago & Northwestern Ry., with headquarters at Winona, Minn., vice W. J. Jackson, deceased. C. H. Wells has been appointed assistant engineer, Iowa Division, with headquarters at Boone, Ia., to succeed Mr. Irving.

John A. McGrew has been appointed general superintendent of equipment and way of the Delaware & Hudson R. R. He entered the service of the Pennsylvania in its engineering department at Wellsville, O., in 1896. About [illegible] he was engineer, maintenance of way, with headquarters in Pittsburgh. He has been associated with the Delaware & Hudson since 1909.

C. E. Skinner, scientist of international reputation, and manager of the research department of the Westinghouse Electric & Manufacturing Co., has been appointed assistant director of engineering in that company. His duties as assistant director will cover research, standards and other work along these lines. He will be located in the main engineering officers of the Westinghouse Electric Co. at East Pittsburgh, Pa.

Obituaries

James Williamson, a retired contractor of Brooklyn, N. Y., died April 5, aged 81.

James J. Lyons, a contractor of Kansas City, Mo., died April 3 at his home, 3319 Oak St., Kansas City, aged 64.

George H. Bodette, formerly city engineer of Toledo, O., died April 11 at his home, 22 Columbia St., Toledo, aged 70.

John G. Motley, a retired civil engineer, died April 1, at his home near Fredericksburg, Va., aged 75 years. He was one of the engineers in building the C. & O. Railroad from Charleston, W. Va., to Gordonsville, Va.

Charles L. Seabury, marine architect and engineer, designer of many fast yachts, died April [illegible] in the New York Hospital of a complication of ailments. He was 61 years old and lived on Columbia Heights, Yonkers. Since 1918 Mr. Seabury had been a member of the firm of Seabury & de Zafra, naval constructors and marine engineers, New York.

William H. Armstrong, a prominent railroad contractor of Canada, died April 2 at Vancouver, B. C. Mr. Armstrong came west with Joseph Whitehead in the early part of 1878. Mr. Whitehead had the contract of building Section 15, on the Canadian Pacific Ry., and Mr. Armstrong, although a very young man, was foreman of buildings and trestles and he erected many of the camps and bridges between Cross Lake and Rat Portage. With M. J. Haney, Mr. Armstrong went to British Columbia to finish the Onderdonk contract between Port Moody and Craigellachie, a very difficult piece of railway construction. Mr. Armstrong built the large bridge across the Fraser river at New Westminster and was connected with the building of many of the docks and bridges in British Columbia. He was connected with Mr. Haney in the building of the Crow's Nest line.

Krox Taylor, president of the Taylor-Wharton Iron & Steel Co., High Bridge, N. J., died April 4. He was the fifth generation of his family to manage the industry which was founded in 1742. He was born at High Bridge on Oct. 29, 1872, and was graduated from Princeton University with the degree of Bachelor of Science in 1894. In college he was a member of the track athletic and football teams and was selected as all-American guard. Mr. Taylor's love of outdoor life led him to engage in mining engineering work in the Rocky Mountains for seven years after leaving college. He returned from the west in 1902 to enter the company's employ. He started in at the bottom and worked up through various departments in the foundry and the old wheel shop, until he became general manager in October, 1905. In 1910 he became president.

Building and Structural Monthly Issue

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Management and Office System

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The Remarkable "Comeback" of the Construction Industry

The construction season opens in March, if we may judge by the relative volume of contracts awarded. March usually shows 50 to 60 per cent increase in value of contracts compared with the monthly average of the preceding two months, and this year is no exception.

It will be instructive to compare total contracts awarded in 27 Northeastern states, as compiled by the F. W. Dodge Co. for the first quarter of the last three years:

	Thousands of Dollars		
	1920.	1921	1922
January	$226,116	$111,605	$166,520
February	200,757	161,677	177,473
March	302,133	164,092	293,636

It should be remembered that contract prices during the first quarter of 1920 were about 25 per cent higher than for the first quarter of 1922.

On the basis of contract prices of 1920, the first quarter of 1922 would show a 10 per cent greater volume of contracts awarded than for the first quarter of 1920; yet the first quarter of 1920 was a boom period, for the "silent panic" of 1921 did not begin until May or June.

On the basis of contract prices during the first quarter of 1921, the volume of contracts awarded during the first quarter of 1922 is 80 per cent in excess of the first quarter of 1921. This is certainly a remarkable "comeback" for the construction industry in the building and public works fields, for the above given totals relate to those fields. Taking only public works contracts in the 27 Northeastern states we have the following totals:

	Thousands of Dollars		
	1920.	1921.	1922.
January	$33,018	$24,186	$18,735
February	35,124	18,547	21,193
March	58,412	33,958	51,997

Judging by the sales of long term municipal, county and state bonds during recent months, it is apparent that the total expenditures for public works during 1922 will exceed even those for 1920, in spite of the lower prices. March, 1922, is stepping on the heels of March, 1920, and is 50 per cent ahead of March, 1921.

If the public can be educated to realize that capital invested in railways should be liberally rewarded, railway construction will again resume its commanding position in the construction world, for America has fallen many years behind in adequate provision for rail transportation. Fortunately there are many able leaders of public thought who, like Herbert Hoover, are urging the people to encourage railway development. Every civil engineer should lend a hand in effecting a "comeback" in railway construction.

The Shortage in Buildings

In our last Building and Structures issue we showed that to overcome the building shortage would require double the volume of the pre-war average of building construction for 1½ years, or 50 per cent annual excess over the pre-war average for three years. This estimate was based on all the building contracts awarded in cities of 3,000 or more population in 27 states during the past 8 years and is, we believe, the most accurate estimate yet made of the shortage in building construction. Moreover, it takes no account of the increase in population since 1914, and is therefore a conservative estimate.

Expressed in dollars, the building shortage is approximately $2,200,000,000 at pre-war prices, or $4,000,000,000 at present prices. The annual investment in new buildings averaged about $1,600,000,000 before the war, or half the total annual investment in all kinds of construction.

In our issue of Sept. 28, 1921, we gave a detailed estimate of national wealth, based on the census of 1910, in which it appears that in 1910 the total investment in buildings was about $36,000,000,000, of which slightly more than half was invested in residences. The value of all land in 1910 was nearly twice the value of all buildings. The per capita investment in buildings was about $400, or about 24 per cent of the total per capita wealth. If we deduct total land value (about 45 per cent of the grand total) the total value of the buildings constituted 45 per cent of all the wealth other than land. However, the total on which these figures are based is incomplete in that it lacks public works and certain lesser items, and it is therefore more conservative and somewhat more accurate to say that buildings constitute about one-third of all the wealth other than land. From this we infer that normally about one-third of the annual "savings" of the country is invested in buildings of all kinds, or one-sixth in residential buildings.

These are impressive figures, and they emphasize the importance of the building industry in its relation to thrift.

Issues of Municipal Bonds Show Great Increase in Public Works

Two periodicals, "The Bond Buyer" and "The Commercial and Financial Chronicle," publish statements of the total issues of "municipal bonds" sold each month. Under the term municipal they include all public works bonds other than those issued by the federal government. They call the long term bonds "permanent loans," to distinguish them from temporary loans. The following figures relate only to permanent loans.

	The Bond Buyer	The Chronicle
[illegible]	$79,161,000	$ 58,839,000
[illegible]	62,980,000	50,109,000
[illegible]	[illegible]	117,136,000

It will be seen that The Bond Buyer's totals exceed those of The Chronicle by about 10 per cent.

In our issue of March 22 it was shown that the total value of "municipal" long term bonds sold annually (as given by The Bond Buyer) is approximately equal to the total amount of state, county and city construction of public works, exclusive of buildings. It was also shown that more than $900,000,000 of municipal bonds were sold during the last six months of 1921, thus forecasting a large construction year in 1922.

In view of the significance of such data we give the long term bond sales for the first quarter of each year for the last 30 years, as published by The Commercial and Financial Chronicle:

	Month of March.	For first three mos.		Month of March.	For first three mos.
1922	...$117,136,337	$295,703,895	1906	...$ 20,332,012	$ 57,030,249
1921	... 50,108,747	201,675,715	1905	17,980,922	35,727,806
1920	... 58,838,866	171,073,118	1904	... 14,723,524	46,518,646
1919	[illegible]	106,239,269	1903	... 9,081,046	30,176,768
1918	[illegible]	75,130,589	1902	7,989,232	31,519,536
1917	[illegible]	101,047,293	1901	10,432,241	23,894,354
1916	[illegible]	120,003,238	1900	8,980,735	34,492,466
1915	[illegible]	[illegible]	1899	5,507,511	18,621,586
1914	[illegible]	165,762,752	1898	6,309,351	23,765,733
1913	[illegible]	72,613,546	1897	... 12,488,809	35,571,062
1912	[illegible]	75,634,179	1896	4,219,027	15,150,268
1911	[illegible]	[illegible]	1895	.. 4,915,355	21,026,942
1910	[illegible]	104,017,321	1894	.. 5,080,424	24,118,813
1909	[illegible]	[illegible]	1893	6,994,246	17,501,423
1908	[illegible]	90,769,225	1892	8,150,500	22,264,431
1907	[illegible]	[illegible]			

*Includes $[illegible] bonds in New York State.
†Includes $[illegible] bonds of New York City.

Increased Consumption of Structural Steel and Its Probable Rise in Price

The revival in demand for fabricated structural steel has been very marked during the last two months, as the following tonnage sales show:

	1920.	1921.	1922.
[illegible]	... 171,123	25,634	78,700
[illegible]	150,[illegible]92	52,376	139,300

The average monthly sales in 1919 were 96,783, and in 1920 they were 96,783, whereas in 1921 they were only 63,189. The "slump period" started in May, 1920, and the sales of structural steel fell off rapidly thereafter, reaching their low mark in February, 1921. Then followed six months when the sales ranged from 52,000 to 67,000 tons a month. The sale revival started last September with 86,000 tons for that month. Now comes March with nearly 140,000 tons, or more than twice the monthly average during 1921, and nearly three times the tonnage sold in March, 1921. Coincidently the price of steel has begun to rise, and will probably continue to rise.

There are several published indexes of steel prices, and they all indicate an average composite price about 30 per cent above that in 1913, or an "index" of 130. It is our opinion that steel will soon be selling at a price fully equal to that of the average of all commodities, or about 150 as compared with 100 in 1913. Expressed differently, it is probable that steel will rise 20 per cent in price within a year, and possibly within three months. The price of steel, it should be remembered, moves rapidly when changes in demand occur.

The Increased Prices of Machinery Compared with Prewar Prices

There are no published price indexes showing the relative prices of machinery. We were, therefore, much interested in some relative prices of farm machinery recently published in the monthly financial bulletin issued by the National City Bank of New York. The prices related to four typical farm implements at Kansas City, Mo.:

	Aug 1, 1914.	Mar 14, 1922.
Price of implements	$376	$717
Freight on implements........	13	24
Total	$389	$741

This indicates an increase of about 50 per cent over the price in 1914, which is probably fairly typical of the ratio of present machinery prices in general to those in 1913 or 1914. If so, it follows that machinery prices have risen no more than the weighted average wholesale prices of the 326 commodities used by the U. S. Bureau of Labor in compiling its wholesale commodity price index.

Determining Penetration of Wood Preservatives

Technical Note U. S. Forest Products Laboratory

The effectiveness of any wood preservative treatment is measured very largely by the depth to which the preservative penetrates. This can be determined by the following tests, which are used by the U. S. Forest Products Laboratory:

The presence of creosote oil is indicated by the dark discoloration, and the degree of penetration may readily be determined by taking a sample at a point free from checks and other imperfections and at a considerable distance from the end. This may be done either with an ordinary ½-in. bit, or with an increment borer, which brings out a core of wood that shows in cross section the depth of penetration and is easily examined. The observation should be made at once, because the oil spreads rapidly over the cut surface. In order to prevent infection, the hole in the treated piece should be tightly closed with a creosoted plug.

As zinc chloride is colorless, the depth of penetration of this preservative must be ascertained by chemical means. After cutting the stick in two or getting a sample with the increment borer, the freshly-cut surface is dipped for not to exceed 10 seconds, in a 1 per cent solution of potassium ferrocyanide, and the excess solution is removed by blotting paper. The sample is then dipped into a 1 per cent solution of uranium acetate, and dried. The treated portions will be whiter than the natural wood, and those untreated will have a dark red or a maroon color. This method does not give very sharp contrasts on wood which is reddish in color, like red oak, but otherwise is very satisfactory and affords a permanent record.

Another method (developed by Galen Wood) consists in spraying over the freshly-cut surface a mixture of equal parts of a 1 per cent potassium ferrocyanide solution, a 1 per cent potassium iodide solution, and a 5 per cent solution of soluble starch. This colors the treated portion a very dark blue, but does not affect the untreated wood. Although the color fades in time, it may be brought back by spraying again.

Sodium fluoride is colorless, and no satisfactory method of showing its presence in wood has been devised.

Mercuric chloride is also colorless, but dipping the wood in a solution of hydrogen sulphide turns the treated area black.

As individual pieces may show an abnormally high or low degree of penetration, a sufficient number of tests should be made to obtain a fair average. Samples should be taken at a considerable distance from the ends of the stick, in order that they will not be affected by the heavy longitudinal penetration from the ends.

Relation of Wages to Per Capita Money for 80 Years

By HALBERT P. GILLETTE, Editor.

A cause-effect relationship is often disclosed by a quantitiative relationship. Indeed, when any two things vary quantitatively through a wide range, in substantially the same degree, it is highly probable either that one of the things is a cause of the other, or that they are both effects of a common cause. Every research scientist is on the lookout constantly for quantitative relationships of the sort just named, for such relationships nearly always disclose a cause-effect kinship.

For several hundred years it has been observed repeatedly that any sudden increase in the quantity of money in circulation in a nation has been soon followed by an increase in commodity prices and in wages. But during the past half century political economists have tended to assign greater weight to the effect of "checking bank deposits" (or "credit currency") than to money in explaining changes in price and wage levels. But if it can be shown that wage levels have moved synchronously with per capita currency in circulation, and not with bank deposits, it will have to be admitted, I think, that political economists have been in error.

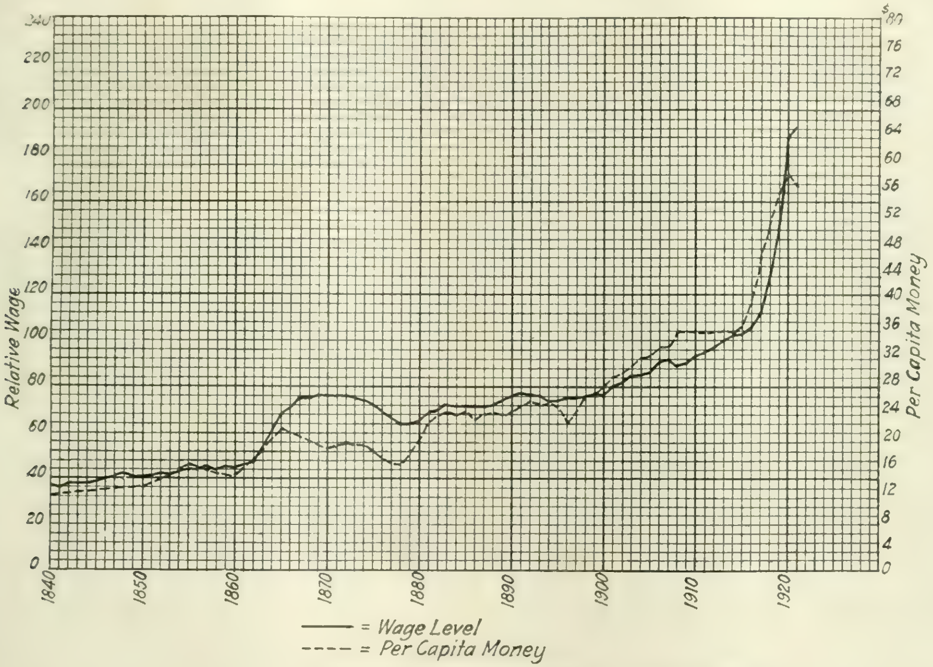


Fig. 1.—Wage Levels in America Since 1840 and Per Capita Currency in Circulation.

Fig. 1 shows two curves, one curve giving relative average daily wages, or wage levels, in America for every year since 1840; the other curve giving per capita currency in circulation for every year since 1870, and for every fifth year prior thereto. The wage curve (or wage index) is based on the average daily wage in 1913 as 100 per cent. From 1840 to 1890 the wage index is that compiled by Falkner and published in U. S. Senate Report No. 1394. From 1890 to 1921, the daily wage index is that for union labor (see bulletins of U. S. Bureau of Labor). I have checked this wage curve at 5 and 10 year intervals against the average annual wages of employes in manufacturing industries, as deduced from census statistics, and I have found substantial agreement with the wage curve except for 1869 and 1919. In those two years, the rapid change in wage levels following a rapid change in per capita money were such that factory wages did not move in entire harmony with union wages. Thus in 1919, union weekly wages are reported by the Bureau of Labor as having been 48 per cent above the 1913 level, whereas factory wages in 17 states averaged 76 per cent above the 1913 level. On the other hand union wages in 1921 averaged 93 per cent above the 1913 level, whereas the factory wages indexed was somewhat below the union wage index. In short, union wages usually move more slowly than other wages both in the rise and on the decline, but in the long run they rise or fall substantially in harmony with other wages.

The wage curve and per capita money curve in Fig. 1 show such a pronounced affinity that I believe no scientifically trained man can look at these curves without being convinced that there is a cause-effect relationship between them.

The first question that presents itself is this: Have increases in per capita money preceded or followed increases in average wages? The answer is that wage level changes have almost always lagged behind changes in per capita money. Note, for example, how the per capita money increased during the world war in advance of increases in the wage level.

Note particularly the fact that during the 80 years covered by the chart (Fig. 1) wages rose from a level of 40 to a level of nearly 200, and that per capita money showed an almost equal increase. Note particularly that about 1916 both curves show a sharp upward turn, the cause (money) changing in advance of the effect (wages).

It has been argued by many bankers and by some political economists that it is almost impossible to determine whether increase in bank deposits ("credit currency") precedes or follows increase in commodity prices; hence that it is very difficult to ascertain which of the two is the cause and which the effect. But such a difficulty does not confront us in regard to money and wages, major changes in the former clearly preceding major changes in the latter.

Thus far we have considered merely major changes, or the general trend of per capita money and wages. Per capita money is not the sole cause of change in wage levels, although it is the major cause. The minor cause is velocity of money circulation, or rate of money turnover, which is an oscillating factor that increases in "good times" and decreases in "bad times," but oscillates about a mean or [illegible]. The product of per capita money and the velocity of circulation gives the wage level, as I showed in an article in Engineering and Contracting Aug. 3, 1921.

But, asks the banker, "How can you ignore the effect of credit [illegible]?" I do not ignore it. An increased volume of credit increases the velocity of circulation of money, because a constant quantity of money is virtually turned over a greater number of times. In this respect all forms of credit are equally effective, but bankers are prone to speak only of bank credits as "credit currency."

During the past 16 years, which is as far back as reliable data are available, per capita bank deposits have become [illegible] what they were, whereas per capita currency has become three-fold what it was. There are about $6 of bank deposits for every $1 of currency, so that, if increases in bank deposits (or credit currency) have the same effect on wages as currency has, then we could practically forget currency and confine our attention to bank deposits. But if this is true, we should expect to find wages almost twice as high as they now are. If we accept the prevalent theory that the volume of bank credits is as important as the volume of money in the effect on commodity price and wage levels, we are confronted with this enigma: How is it that wage levels have followed per capita money, but have shown no such relation to bank deposits although the volume of bank deposits is [illegible] the volume of money? I leave this enigma to the defenders of the prevalent theory that "credit currency has the same effect on prices and wages as has real currency." Unless they can answer it satisfactorily their theory stands refuted.

According to Prof. King about 75 per cent of the annual income in America goes to manual and mental workers, and 25 per cent to capital. Hence commodity price levels would move approximately with wage levels in the long run, were it not for changes in efficiency of production. A general increase in efficiency of production lowers prices almost in exact proportion thereto, as I showed by statistical evidence in Engineering and Contracting April 7, 1920. As there shown the commodity price level is proportional to the product of the per capita current and the velocity of circulation divided by the per capita efficiency of production. I showed that the per capita efficiency of production had never increased more rapidly for a decade than 25 per cent. Hence if we assume a stationary wage level, average commodity prices (or price index) will probably not fall more rapidly than 2.5 per cent yearly over a long period of years.

Per capita currency in circulation is about 50 per cent above that in 1913; but our per capita gold is 80 per cent above that in 1913. In view of the great volume of gold, bank deposits will ultimately increase, and paper money will increase. So for the next few years the prospect is that our per capita currency will increase; it may even rise to a point considerably higher than it reached in 1920 or 1921. In which event wages will again rise, and they may attain a level 20 per cent or more above the present level.

It is astonishing to observe with what complacency most business men and bankers talk as if it were certain that wage and price levels would recede to the prewar level within the next few years. Many of them point to the fact that after the Civil War, commodity price levels declined until in 1878 the price level of 1860 was again reached. They are ignorant of the factors that determine price and wage levels, yet they talk with great assurance about the prospects of a [illegible] decline in commodity prices and wages. Ask them what are the prospects of further decrease in per capita money, and they have no opinion, yet per capita money is the main factor that determines wage levels. Ask them as to the prospect of a steady increase in productive efficiency and they are equally hazy; yet it is only by a steady increase in productive efficiency that commodity price levels can be lowered in the face of stationary or rising wage levels.

But I repeat that the general trend of wages has been upward [illegible] years. The wage level in 1860 was 47 as compared with 100 in 1913. Even before the world war the wage curve was [illegible] more and more steeply upward, following the per capita money curve. The increasing production and [illegible] of gold had for many years been the cause of rising wages in America. But with the introduction of our Federal Reserve Banking System there came a means of increasing the volume of paper money at a rate even faster than before the world war. Our banks were not slow to put out vast quantities of paper money prior to the depression of 1920, and we may be sure that with the revival of business they will put out even greater quantities of federal reserve notes than ever before. Our vastly increased quantity of gold will make it economically safe to issue a correspondingly increased volume of paper money (federal reserve notes), and nothing short of a change in the law is likely to prevent enormous inflation of our currency during the prosperous years upon which we are now entering. Any manufacturer or contractor who contracts for the delivery of goods or structures many months in advance, basing his estimates on existing wages and prices, will run not a considerable risk of loss. This will probably hold true for several years to come.

Index Numbers of Wholesale Prices 1913 to March, 1922

The accompanying tabulation shows the index number of wholesale prices by groups of commodities, as computed by the U. S. Bureau of Labor Statistics. The group of miscellaneous commodities includes such important articles as cottonseed meal and oil, lubricating oil, jute, rubber, newsprint and wrapping paper, rope, soap, laundry starch, tobacco, Manila hemp, sisal, phosphate rock and wood pulp. The commodities composing the other groups are as indicated by the title:

INDEX NUMBERS OF WHOLESALE PRICES IN SPECIFIED YEARS AND MONTHS 1913 TO MARCH 1922 BY GROUPS OF COMMODITIES (1913=100.)

Year and month	Farm products	Food, etc.	Cloths and clothing	Fuel and lighting	Metals and metal products	Building materials	Chemicals and drugs	House furnishing goods	Miscellaneous	All commodities
1913	100	100	100	100	100	100	100	100	100	100
Jan.	97	99	100	[illegible]	107	100	101	100	100	100
April	97	96	100	[illegible]	102	101	101	100	98	98
July	101	102	100	[illegible]	98	101	99	100	101	100
Oct.	103	102	100	[illegible]	[illegible]	98	100	100	100	101
1914	103	103	98	[illegible]	87	97	101	99	99	100
Jan.	101	102	98	[illegible]	92	98	100	99	99	100
April	103	95	99	98	91	99	100	99	101	98
July	104	104	99	95	85	97	99	99	97	100
Oct.	103	107	97	93	83	96	105	99	96	99
1915	105	101	100	93	97	94	114	99	99	101
Jan.	102	106	96	[illegible]	83	94	103	99	100	99
April	107	105	[illegible]	[illegible]	91	94	102	99	99	100
July	108	104	99	[illegible]	102	93	108	99	98	101
Oct.	105	103	103	[illegible]	100	93	124	99	99	101
1916	122	126	128	[illegible]	148	101	159	115	120	124
Jan.	108	113	110	[illegible]	[illegible]	99	[illegible]	105	107	110
April	114	117	[illegible]	[illegible]	147	101	172	108	110	117
July	118	121	[illegible]	[illegible]	145	99	[illegible]	121	[illegible]	119
Oct.	136	140	138	[illegible]	[illegible]	101	[illegible]	124	132	134
1917	189	176	181	[illegible]	[illegible]	124	198	144	155	176
Jan.	148	150	[illegible]	[illegible]	[illegible]	106	159	132	[illegible]	151
April	181	182	[illegible]	[illegible]	[illegible]	114	170	139	149	172
July	[illegible]	181	[illegible]	[illegible]	[illegible]	132	198	152	153	186
Oct.	198	183	[illegible]	146	[illegible]	114	252	152	163	181
1918	220	189	[illegible]	[illegible]	181	151	221	196	193	[illegible]
Jan.	207	187	211	[illegible]	[illegible]	136	[illegible]	161	178	185
April	217	178	[illegible]	[illegible]	[illegible]	146	229	172	111	190
July	224	184	[illegible]	[illegible]	184	154	[illegible]	199	190	[illegible]
Oct.	224	201	[illegible]	[illegible]	187	[illegible]	218	226	196	204
1919	231	210	[illegible]	[illegible]	[illegible]	152	[illegible]	236	211	212
Jan.	[illegible]	207	[illegible]	[illegible]	[illegible]	161	191	218	212	[illegible]
April	[illegible]	211	[illegible]	[illegible]	[illegible]	162	178	[illegible]	216	[illegible]
July	246	216	[illegible]	[illegible]	[illegible]	186	171	[illegible]	[illegible]	[illegible]
Oct.	[illegible]	211	[illegible]	[illegible]	161	231	174	264	220	[illegible]
1920	218	[illegible]	[illegible]	[illegible]	[illegible]	208	210	366	236	[illegible]
Jan.	246	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	324	227	248
Feb.	[illegible]	244	[illegible]	[illegible]	[illegible]	[illegible]	197	329	[illegible]	[illegible]
March	[illegible]	246	[illegible]	[illegible]	[illegible]	[illegible]	205	[illegible]	[illegible]	[illegible]
April	246	270	[illegible]	[illegible]	[illegible]	341	212	321	238	[illegible]
May	[illegible]	287	[illegible]	[illegible]	[illegible]	341	215	[illegible]	246	[illegible]
June	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	218	[illegible]	247	[illegible]
July	[illegible]	268	[illegible]	[illegible]	[illegible]	[illegible]	217	362	[illegible]	262
Aug.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	328	216	363	240	[illegible]
Sept.	210	[illegible]	[illegible]	[illegible]	[illegible]	318	[illegible]	371	[illegible]	[illegible]
Oct.	182	204	[illegible]	[illegible]	[illegible]	[illegible]	216	371	229	[illegible]
Nov.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	207	369	220	207
Dec.	144	172	[illegible]	[illegible]	[illegible]	266	188	316	205	189
1921										
Jan.	[illegible]	162	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	190	177
Feb.	[illegible]	150	[illegible]	[illegible]	[illegible]	[illegible]	178	277	180	[illegible]
March	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	171	[illegible]	167	[illegible]
April	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	168	[illegible]	[illegible]	[illegible]
May	[illegible]	[illegible]	181	[illegible]	[illegible]	[illegible]	166	[illegible]	151	[illegible]
June	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	166	[illegible]	150	148
July	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	149	[illegible]
Aug.	118	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	161	[illegible]	[illegible]	[illegible]
Sept.	[illegible]	146	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	146	[illegible]
Oct.	118	[illegible]	190	[illegible]	[illegible]	[illegible]	[illegible]	218	[illegible]	[illegible]
Nov.	114	[illegible]	186	[illegible]	[illegible]	[illegible]	[illegible]	218	[illegible]	[illegible]
Dec.	114	[illegible]	185	[illegible]	[illegible]	[illegible]	161	[illegible]	138	149
1922										
Jan.	116	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	159	[illegible]	146	[illegible]
Feb.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
March	[illegible]	[illegible]	151	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

How Local Engineering Societies Can Serve the Public

Comments on Suggestions in Editorial in Feb. 22, Issue of Engineering and Contracting

Public Should Be Informed as to Value of Engineer

That the engineer should take his place in guiding public opinion will be admitted by those who understand the situation, but the difficulty of so doing lies in the fact that the public does not realize that the engineer is particularly suited for such service.

That the value of the engineer may become known, it is necessary that some cheap and effective method be devised whereby the public may learn of the service that engineers have to offer. This may be done by local engineering societies or those affiliated with national organizations by taking into consideration matters concerning the public in their discussional meetings, and having their plans and recommendations published so that people may know that the engineer is interested in something other than technical subjects.

To carry out any plan to place the engineer to the front in public activities, funds will be required. But the engineer is one who will want to be shown just what his money will do before he will subscribe to the fund. But I believe that through local activities he will realize that he has a place to fill in public affairs, and because of his aroused interest will gladly help toward the advancement of the engineering profession. L. H. HAHN.

Madison, Wis.

Chapter Takes Active Interest in Civic Affairs

The Milwaukee Chapter, A. A. E., has taken an active part in certain matters of public interest in Milwaukee. Last year our public relations committee gave careful study to the preparation of a report on the proper location of a proposed terminal for a proposed car ferry line which was to operate between Muskegon, Mich., and Milwaukee. This report was submitted to the public and to the Association of Commerce. The question was as to whether the terminal should be located up the Menominee River, past several bridges, or whether it should be located near the harbor mouth, where no bridges would be crossed.

This year, 1921-22, our public relations committee has prepared a study and report on the development of the new outer harbor. This was a very comprehensive paper and was submitted to the Association of Commerce, and it is believed that it will have weight in promoting the securing of appropriations and the upbuilding of the new harbor, which will be of great importance in case the St. Lawrence waterway is developed.

The committee is now studying the matter of street development and widening and civic centers.

We have a representative serving on the safety commission of the city of Milwaukee. Also a representative on the civic council. One of our members has also recently been appointed on the sewerage commission.

We believe that engineers should take a genuine interest in public affairs and seek election to office when the opportunity offers. N. M. WORKS.

Secretary Milwaukee Chapter American Association of Engineers.

Milwaukee, Wis.

Let the Public Know Just What an Engineer Is

It appears to me that a good plan would be to have civic bodies who are interested in improving conditions, have one of their members write a well-thought-out and carefully prepared paper on the matters in which they are interested, take the matter up with the officers of the local engineering society and read it at one of their meetings. This is a matter which is very easy to arrange, as most of the engineering societies are very glad to hear papers prepared from other than a strictly technical standpoint, and are always willing and ready to co-operate in any movement of benefit to the community in general. However, no engineering society that goes in for partisan movements can hope to exist for any length of time, for the very simple reason that the members are drawn from all political divisions. To draw an engineering society into political wrangles would soon very effectually break it up.

What our engineering societies have been doing, in some measure, and what I think that they should concentrate on, is to educate the public as to just what an engineer is. Most people think that an engineer can do no other thing than design structures, machinery and other devices, or make maps and surveys. What they do not seem to understand is that the chief function of an engineer is to conceive, finance, organize, design, erect and, last but not least, economically operate public works.

In many places we find waterworks, sewerage and drainage systems being operated under the charge of men not conversant with the essential principles of engineering. There are many cities in which the health board is made up entirely of doctors and civilians. Now it is very well for medical men to find out what is desirable for the health of a community, but it is absolutely up to an engineer to decide how the remedy is to be applied, with the funds available, and to decide what funds are needed. In many cases the advice of an engineer in financial matters would be of decided advantage to public boards because of his natural tendency toward the conservative side of all financial transactions.

It would be well for communities if the administrative head of all departments doing construction or maintenance work was a thoroughly qualified engineer of acknowledged standing. Furthermore, he should be untrammeled by partisan politics. Unfortunately, this is not likely to be permitted.

I believe that if it were possible for the engineering societies to organize small active units (committees) who would constantly keep before the legislature and governor of each state the necessity of appointing on all public boards at least one engineer who would be a member of the board, not an employe, then the engineer would, indeed, get into a position in which he could do the most for his community and gain the recognition which he deserves.

I believe that if it were possible to keep city engineers and engineers in charge of other public boards free from political entanglements and undue influence, all public works would be conducted on a much more economical basis than is at present usually possible. This is a matter which is up to the voters of the community. If, as usually happens, most of the business men of a community are so engrossed with their personal business that they cannot find time to register or to vote more than once in several years, then the responsibility rests with them and what happens due to the politicalization of public works, is beyond anything that the engineering societies can correct.

When the public awakes to the necessity of placing in charge of public works only men who have been trained to handle large engineering problems, then, and only then, will they reap the harvest of benefits which economical construction and operation can produce. In the meanwhile, all that the engineering societies can do is to so organize and co-operate that the benefits of engineering knowledge and training on public boards shall be persistently and forcibly brought to the attention of our governors and legislatures.

If the taxpayers' associations and other civic associations could be brought to understand that it is to their interest to help out in this matter, not so much with the idea that they will thereby reduce taxation, but that by doing so they will get a maximum return on taxes paid, it might be possible to get them to bear their share of the expense involved, which will not be light. I fear, nevertheless, that this expense is more than likely to be forced on the engineers alone, who, unfortunately, are hardly in a position to bear it. One other thing which I would like to bring out is that the engineers themselves should make every effort to see that no one is employed in an engineering capacity who is not fully qualified to do work of an engineering nature.

EUGENE F. DELERY.

New Orleans, La.

Arousing the Interest of Engineers in Civic Affairs

I am most heartily in sympathy with the sentiments of the editorial and during the past two years as chairman of the civic-improvement committee of the Los Angeles Chapter American Association of Engineers I have kept that idea foremost in my mind, and whenever possible have attempted through our meetings to arouse the interest of the engineers in civic matters. My contention has been that not only were they interested as taxpayers and as citizens, but, furthermore, due to the very nature of their training and experience, they were better qualified than most persons now endeavoring to solve the many problems which come before any community, and especially one growing as fast as Los Angeles. As you suggest in your editorial, I have found that very few engineers have the time to give to the study of these matters, and hence, what little they do, must be under more or less of a handicap.

Another difficulty which I have encountered is that I believe the majority, or at least a goodly number, of our engineers are employed in either city, county, state or federal service, and as such they usually are subject to civil service rules which in nearly all cases specifically state that a civil service employe must not take part in activities of a political nature, and I have found many of our most able engineers reluctant because of this very thing to join in or take part in many issues.

The writer, speaking before our Association not more than three months ago, urged the very things which you have set forth in your editorial.

I am heartily in sympathy with your sentiments and hope that we may be able to do something here in Los Angeles along these lines, but feel that a better start can be made if publications such as yours will keep this continually before the engineer until he actually believes it himself, and will come out of his shell, so to speak.

J. HUNTER CLARK,
Secretary, Los Angeles Chapter, A. A. E.
Los Angeles, Calif.

What the Engineers' Club of Minneapolis Is Doing

I will outline some of the activities of the Engineers' Club of Minneapolis:

Beginning on the 10th of November and continuing through to the 16th of March, we have held weekly joint luncheons with the Minneapolis Chapter of A. I. A., at which we have had speakers who have given short talks upon subjects of interest to all engineers and architects, as well as the general public. The subjects discussed have included the following: The General Economic Outlook; The Outlook for Financing New Construction; Freight Rates on Construction Materials; The Why of the A. G. C. A.; Recent Developments in Chemical Engineering; Recent Developments in Electrical Engineering; Building Conditions in Minneapolis; Conditions in the Lumber Business; Work of the National Chamber of Commerce; Advertising for Architects and Engineers; The Proposed Federal Reserve Bank of Minneapolis; Reciprocal Relations of the Engineer and Attorney; The Minneapolis High Dam; Character Analysis; Industrial Relations; The St. Lawrence Waterway.

Among the committees which are standing committees in our club is the one on civic problems, composed of prominent engineers and men of affairs, and whose duty it is to take up local questions, political and otherwise, in which the engineers are interested.

We have at the present time a committee investigating recent awards of paving contracts in the county of Hennepin.

At our regular monthly meeting, March 21, where 89 were present, we discussed inland waterways, including specifically the improvement of the Mississippi River for water transportation and the St. Lawrence Waterway. A very full discussion of the St. Lawrence Waterway took place after the regular speakers had finished their presentations, covering the pros and cons of the whole matter, and a motion was then made and passed unanimously endorsing the project and providing for conveying this endorsement to Congress. A special committee was appointed to provide ways and means of getting before the public in printed form the gist of this discussion for the purpose of promoting the project. Another committee was appointed to further discuss the Mississippi project and bring in a report for final action at the next meeting of the club.

Our club is represented on many of the committees of the Civic and Commerce Association, which is the central organization of the business interests of Minneapolis which digs into all public affairs. Our club is also represented on the city planning commission and other bodies, including the president of the park board and the superintendent of parks and, of course, in all branches of the city engineering department.

Now, one big thing which we have accomplished by our weekly luncheons, has been to arouse the interest of the local press. They have had reporters at practically all of our meetings and have written them up in good shape in the daily papers, and they are also sending reporters to our evening meetings and writing these up as they have never been written up before. This publicity is putting the engineer and his work before the public in a very favorable light and adding greatly to his influence in public matters.

Practically all of the subjects which we have discussed have touched upon public questions in one way or another. We hope by following our present course to increase more and more the public esteem for the knowledge of the engineer in public matters so that he will be called upon more as time goes on to take part in public affairs and help to mold public opinion.

We believe that we are doing a real service to the public, and it is costing us very little in money, something in time, of course, but we feel that the results justify the effort.

Yours truly,
WALTER H. WHEELER.
President, The Engineers' Club of Minneapolis.
Minneapolis, Minn.

Chapter Has Civic Committee

This chapter has already appointed a civic committee to investigate matters such as referred to in your editorial of Feb. 22. It is their duty to notice and call to the attention of the chapter all cases where they believe or suspect that the funds of the taxpayers in this community are being wasted or used fraudulently. It is the intention at this time that their activity will be confined to engineering cases, but after the committee gets working properly it may very possibly prove advisable to extend their powers to broader fields.

L. K. RUTTKAY, JR.,
Secretary, Helena Chapter A. A. E.
Helena, Mont.

Atlanta Adopts Zoning

Atlanta, Ga., adopted a zoning ordinance April 10 by a nearly unanimous vote of the council. The ordinance divides the city into dwelling house, apartment house, business and industrial districts. Three classes of height districts are established with limits of 50 ft., 100 ft. and 150 ft. respectively. Building line, side yard and rear yard requirements are established for all buildings in the residence districts. Lot area requirements are based on the number of housekeeping units for which the residence building is arranged; 5,000 sq. ft. of lot area per family is required for much of the dwelling house area and 2,500 sq. ft. of lot area per family for the areas suited to double or two family house development. In most of the apartment house areas only 625 square feet per family is required, while in the limited hotel and elevator apartment sections there is no minimum lot area requirement, though side, rear and front yards are required.

The zoning plan and ordinance was prepared for the Atlanta Plan Commission by Robert Whitten, city planner, Cleveland, O. The initial indifference or opposition of the public was overcome by an intensive educational campaign in which newspaper articles, editorials and cartoons played an important part. Five thousand copies of a tentative zoning map and of an attractive illustrated pamphlet describing the proposed zoning and giving the reasons why zoning is necessary, were distributed. Work on the zoning was started by Mr. Whitten in May, 1921, and the zoning ordinance became effective in April, 1922, a little less than a year from the time the work started.

Portland Cement Output in March.—Portland cement production in March amounted to 6,685,000 bbl., according to the U. S. Geological Survey. Shipments totaled 7,002,000, and the cement in stock at the end of the month, 13,824,000 bbl.

Highway Bridges Over Spillways of Dams of Miami Conservancy District

Highways cross the valleys on the tops of all five dams of the Miami Conservancy District of Dayton, O. The spillways are spanned by concrete bridges of the deck girder type. A number of unusual features included in the design and construction of these bridges are described in the April Miami Conservancy Bulletin, from which we have taken the notes that follow:

Two 20-ton trucks traveling in the same direction and passing over the bridge side by side was selected as the maximum "live" load for the design. The load on the rear axle of each was taken as 14 tons, and on the front axle as 6 tons. Besides the "live" load, the bridges are designed for the dead weight of the bridges themselves, and an impact or blow equal to 30 per cent of the live load.

The situation of the bridges imposed certain limitations on the type of structures selected. The abutments for three of them, Lockington, Taylorsville and Huffman, are the high side walls of the outlet structures, while the abutments for the bridge at Englewood are the spillway walls of less height, but high enough to be a special problem in themselves. The Germantown bridge is situated unlike any of the other four. The requirements of flood protection imposed other limitations. The spillways are designed for a maximum water depth varying from 10 ft. to 14 ft. at the different dams. Three feet was decided upon as the minimum distance between the maximum water surface and the bottom of the bridges. Types of structures giving long clear openings to prevent possible clogging by drift, and to permit as large a discharge as possible, were also desirable. Permanence, safety, good appearance, and economy in cost were also necessary features.

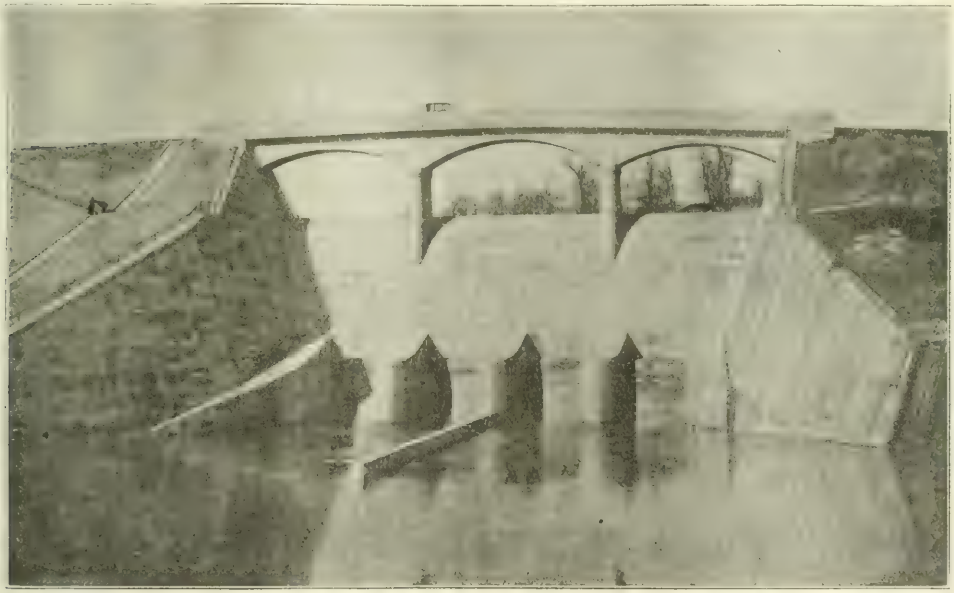


Fig. 1.—View Taken March 3, 1922, of Outlet Works at Taylorsville Dam Showing Bridge Over Spillway.

Steel truss bridges were planned originally, and the walls that would later be their abutments were designed and built for that type of bridge. A change was made later to concrete as the bridge material to be used, and the deck girder type was selected.

Of the girder types, the most desirable would be a single span, reaching from wall to wall, and without piers in the waterway. However, the dead weight of the girders would have been so great, due to their great length (80 to 144 ft), that a departure from conservative designs would have been necessary. Such a departure from accepted engineering practice was not thought advisable in such vital structures as these. Therefore, the use of piers, placed on top of the spillway weirs, and spaced far enough apart to give a wide clear waterway, was decided upon, thus reducing the length of girders to within the 60-ft. mark.

All the bridges, save at Englewood, where there are special conditions, are built on vertical parabolic curves. Elaborate features that would run up the cost were not added, but every effort was made to give grace and beauty to the structures. At Lockington and Huffman but two spans were practical. This forced the use of a plain deck girder bridge at each place. At Taylorsville the length of opening and number of conduits underneath, permitted the use of two piers for the bridge. The simple girders on the two end spans were cantilevered out to form the center span. The structure at Germantown is a simple deck girder bridge. Its location, down in a hollow, did not call for special treatment.

The most suitable fundation for the Englewood spillway was a rocky ridge at the west end of the dam, close to the Dayton, Covington & Piqua Traction Line, and the Covington Pike. By relocating about 1,800 ft. of the traction line and running it through a supplementary opening just west of the main structure, a grade crossing at the end of the spillway bridge was eliminated. The elevation of the highway above the top of the dam, and the necessity for clearance over the track resulted in the bridge being built on a 5 per cent grade, instead of the usual parabolic curve. The closeness of the structure to the road, and the grades, necessitated a flared out floor on the west end to make a good connection with the pike. Because of the unequal length of the spans, the shallow beams over the traction line and the odd shaped floor, it was impractical to use anything but the deck girder type of bridge.

The spillway at Germantown is in a rocky saddle in the hills, some distance from the dam. A notch has been cut in the rock to the required depth, and some concrete collars placed across the notch, making a very simple structure. The bridge spanning it was not limited in any way as to length, nor in length of pier. Two piers were used, and three parallel girders with a concrete deck comprise each span. The Germantown structure was designed and built before work was started on the other four.

A different situation existed at the other four dams, especially at Lockington, Taylorsville and Huffman, where the

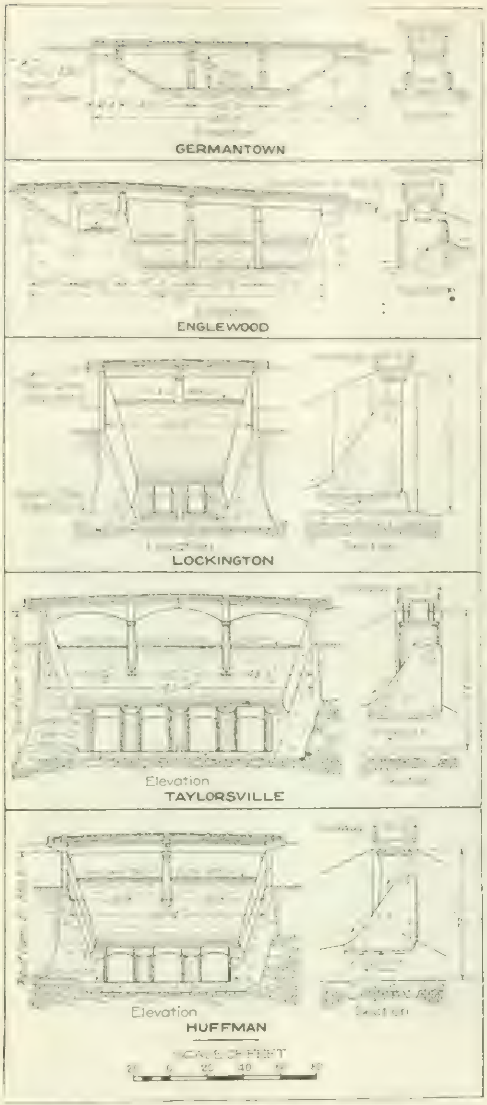


Fig. 2.—Comparison of the Five Spillway Bridges.

ogee spillway weir is of considerable height. After the Germantown bridge was built, the Lockington structure was considered. As mentioned above, the original intention was to use steel trusses to span the spillways, and the notches cast in the side walls of the outlet structure to receive the Lockington spillway weir were set well downstream. By the time the construction of the earth embankment had reached the stage where the spillway weir could be placed, a concrete bridge had been decided upon. Even by setting the weir upstream as far as the notches permitted, a pier placed on top could be but 8 ft. long. A longer pier could not be provided without shifting the centerline of the bridge downstream from the centerline of the dam, which was undesirable. It was then decided to bracket out the top of the pier by the use of cantilever projections, but even then the top of the pier was quite short. To meet this unusual condition, a two girder bridge with a cantilever deck was developed that proved to be so advantageous that similar ones were used at Taylorsville, Huffman and Englewood, although at all three of these places piers long enough to have accommodated three girders could have been placed on top of the spillway weirs.

The girders at Taylorsville are fixed at the piers. Expansion and contraction movement is provided for by sliding plates at the abutments and by the open joint at the center of the structure. The other bridges are provided with sliding plates at either piers or abutments.

The floor slab is similar in all of the bridges. As shown in Fig. 3 the floor slab and curb overhang the girders which support them. This gives a simple span between the girders and two cantilever projections or brackets on the outside. The cantilever projection and the simple span balance each other, and therefore, the slab of the simple span need not be as thick and strong as would be necessary if the cantilever projections were not used. The simple span is designed as if the rear wheels of the 20-ton truck were distributed over 5 ft. 9 in. in length, of the floor. The overhanging cantilever part of the floor is designed as if the same load were distributed over 2 ft. in length of the floor.

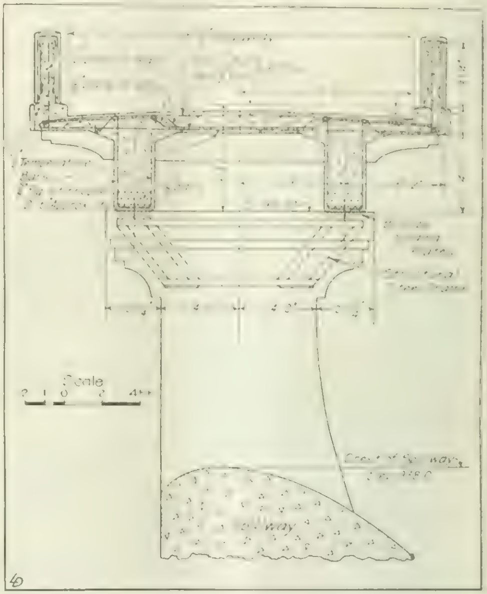


Fig. 3.—Cross Section of Lockington Spillway Bridge.

When the spillway weir was cast, a notch or seat was left to receive the bridge piers. These notches had horizontal bearing faces; if stepping was necessary, it was done by vertical and horizontal steps. The forms for the entire structure were erected complete, except for the railings. The footings for the falsework were stringers fastened to the curved face of the weir by bolts previously cast in the weir. The concrete proportions were 1:2:4. The reinforcing was ovoid deformed bars, and was wired into position before concrete was poured. The gravel washing plants that were used in building the outlet structures were also used to prepare materials for the bridge work. The concrete was mixed and handled in bottom dump buckets. A steel derrick, mounted at Taylorsville and Huffman on one of the berms of the dam, and at Lockington and Englewood, on the floor of the spillway, picked up the buckets full of concrete, and hoisted them up to the bridge. Each span, including the curbs, was made in one continuous pour. The Germantown bridge, being quite a distance from the dam, used a small mixer at one end of the bridge. The forms remained under the bridges for about three weeks after pouring.

The roadways of the bridges will be paved with a bituminous macadam material.

Report of Associated General Contractors on the Knickerbocker Theater Collapse

At a meeting of the Executive Committee of the Associated General Contractors of America, held immediately after the collapse of the Knickerbocker Theater Jan. 28, 1922 a committee representing engineers, contractors, and the public was authorized to make an investigation and report of the matter for the Association. This committee was appointed as follows: Rudolph P. Miller, Consulting Engineer, formerly superintendent of the Building Department, New York; James Baird, Vice-President, George A. Fuller Company, and Guy Mason, of Mason and Spauling, attorneys, Washington, D. C. W. P. Christie, Research Engineer of the Associated General Contractors, served as secretary and technical assistant to the committee.

The report of the committee rendered on March 14, contains about 9,000 words and 11 illustrations. It is divided into two parts, the first giving a more or less general statement of the case; the second including a history of the structure, details of certain observations and conclusions and a resumé of a half dozen previously propounded theories of the collapse, with comments upon them and a pointing out of defects in all the theories except that of the Engineering News-Record, which was substantially in accord with the report of the committee.

In brief, the conclusion of the report is that the structure was full of defects, no single one of which was necessarily sufficient to cause collapse, but which in combination produced the terrible result. All of the fatal defects so far as noted were in the design; such defects as have been discovered in the construction not being held directly contributory to the collapse. The contractor was however at fault in having violated the building code.

This report, based upon careful study and deliberation, is probably the best that has been made upon the collapse, and is worthy of attention by structural engineers, architects and contractors.

The following condensation is about one half the length of the entire report, and is taken chiefly from the first part:

Purpose of Report.—From the facts and circumstances revealed by the investigation, it has been the purpose of the committee primarily to derive information which can be utilized in eliminating as far as possible such disasters in the future.

Causes of the Collapse.—The collapse of the Knickerbocker Theater roof is attributed by this committee to unseating the north end of the main truss, primarily through failure of the northernmost top gusset plate of that truss and the bottom chord where it rested on the Columbia Road wall. This half-inch gusset plate, which furnished the only lateral stiffness of a heavy upper chord, buckled to the west, and the lower chord where it rested on the wall, without reinforcement for bearing stresses and eccentricity was crushed and tilted under a combination of tension, compression and torsion, or twisting stress. This action culminated from many weaknesses of design, the most vital of which were as follows:

First: The over-stressing of steel roof members which produced excessive downward deflection of the main truss. This over-stressing resulted from (a) using loads for the design which were greatly exceeded by the actual load, (b) from reducing the height of the main truss, as originally designed, and (c) from failing to splice the top and bottom moment plates which were placed on the truss in short sections, and did not butt together.

Second: The designing of the main truss bearing so that the center of stresses fell on the edge of the wall, thus producing eccentricity and tension in the bearing.

Third: The failure to anchor trusses to the walls, especially over a short skew bearing at the wall support of the main truss. This design failed to provide for the additional outward thrust against the wall which developed, at such a bearing when the truss is deflected.

Fourth: The failure to reinforce the bottom chord of the main truss where it bore on the wall or even to connect the channels of this chord where they extended beyond the gusset plate to form the bearing. Thus no adequate provision was made in the bottom chord for three additional stresses acting upon it, over and above the load which it carried as a member of the truss. These stresses were (a) the full load of the north end of the truss, (b) a twisting caused by the skew bearing, and (c) the tension caused by the center of stresses falling on the edge of the bearing instead of at the center.

Fifth: The omission of a cover plate at the junction of the top chord and batter post of the main truss, thus limiting the stiffness of the truss to that of a half-inch gusset plate at that point.

Sixth: The placing of a heavy concentrated load on a high and relatively thin hollow tile wall, neither adequately braced nor integrally bonded and further weakened by many openings and chases.

Seventh: Lack of adequate diagonal of other bracing throughout the steel structure and especially around the two columns carrying roof trusses, thus providing insufficient rigidity to the structure as a whole.

One or possibly all of these weaknesses might have been present in the building without causing collapse—had their effects been distributed to various parts of the structure; but unfortunately it occurred that these effects combined and concentrated at the north end of the main truss. The culmination of this condition in a final collapse is herewith summarized:

Design Change and Bad Details.—As already mentioned, the actual roof load greatly exceeded the design load; the main truss was reduced about 9 inches in depth from the original design, and its moment plates were neither butted together nor spliced. These factors all produced excessive downward deflection of that truss. This deflection, acting on the skew bearing, created a thrust at the Columbia Road wall, which tended to push the wall outwardly and to twist the bottom chord of the truss. Either of these movements, occurring in but a small degree, was capable of unseating the truss, as its bearing perpendicular to the wall was only 6 inches and that parallel to the bottom chord 8 inches.

To resist this twisting force the only stiffness provided was that of a half-inch gusset plate and of the bottom chord in the first panel. The batter post could contribute nothing as its rigidity was in turn limited by a half-inch gusset at its upper end. Thus the bottom chord, from the twisting force alone, was probably in a hazardous condition. Furthermore, the two 12-inch channels forming this member extended beyond the gusset plate with their webs unsupported, forming an eccentric bearing. These webs therefore took practically the full bearing load of the truss and the stress from its eccentric bearing as well as the twisting force.

Failure Inevitable.—Under such a combination of stresses failure in the bottom chord, or bearing, was at some time almost inevitable. A condition existed that would have been dangerous with a thoroughly adequate wall, and when with this was combined a thin wall badly cut up by openings, a condition must have existed which awaited but an additional load, a measure of vibration or fatigue of the over-stressed metal to result in a collapse.

Snow Load and Vibrations.—The additional load and probably the vibration and fatigue were present when the roof gave way. A snow load of some twelve or thirteen pounds per square foot, or about 16 per cent of the dead load (computed from precipitation recorded by the U. S. Weather Bureau), exclusive of possible drifting, and the heaviest since completion of the building, was on the roof. Vibration from passing street cars had been noted on the structure and was doubtless accentuated at times by a double eight-foot ventilating fan carried on the roof. The snow load which increased the dead load at the north end of the main truss some 15,000 pounds was, so to speak, the last straw in destroying equilibrium at the support. It undoubtedly provided the additional stress necessary either to buckle and twist the member resting on this bearing, or to buckle the gusset plate above. Which action took place first it is impossible to state, but that both actions did occur is shown by the distorted steel members and marks on the north bearing.

The Weak Wall.—When the web of the east channel of the bottom chord buckled, the top of that member (not the whole truss) was twisted eastward, thus unlining the batter post, and moving the center of stresses off the bearing. With the bottom chord in this condition only the lateral stiffness of the wall could prevent the truss from sliding off. This stiffness the wall did not have. It was pushed outward about [illegible] sufficient to break its bond with the stage wall, to wreck the stage wall itself and to allow the truss to drop.

Whether the upper gusset plate or the bottom chord channel failed first is immaterial, as either action would have brought about the other and would have thrown the batter post out of line. Once this member was displaced, collapse readily followed. Unfitting or distortion, of the batter post is a condition that easily results in failure of even a well-built truss.

Failure Did Not Start with Auxiliaries.—No failure of an auxiliary truss was essential to unseat the main truss, and no failure of a beam, as they were actually erected, is believed to have been capable of causing a failure in the auxiliary truss T 12. In no member of the steel, except the bottom chord mentioned, has any evidence of failure between supports and before falling been found. Collapse through a succession of preliminary failures seems highly improbable in view of the difficulty experienced in efforts to cause collapse when demolishing structures.

It is common knowledge to men of experience in the wrecking of old buildings that a sudden collapse or giving away of any large portion of the structure can be effected only by destroying a major supporting member. The only member of this nature existing in that area at which eye witnesses say the failure began was the north end of the main truss, and the suddenness with which this truss collapsed seems to preclude the possibility of it having been unseated by the failure of a minor member of the steel framing.

Responsibility.—In the erection of a building, particularly a building to be used as a public gathering place, all persons engaged in designing and erecting the structure, like the operators of public utilities, are jointly and severally responsible for its safety. This responsibility is entailed by the fact that their operations are intimately connected with the public welfare.

The highest degree of responsibility undoubtedly rests upon the architect, as it is upon him that an owner relies for a properly constructed building; but every other agency involved in the project has an individual responsibility for the character of its work. This individual responsibility may be somewhat limited by practical limitations of service, but, nevertheless, it is constantly present. Each agency presuming to render construction service, from the contractor to the fabricator, is obligated to communicate to the architect any knowledge that may bear on the safety of the structure. If any agency finds that, in its judgment, changes should be made in the plans to insure structural safety, it is the duty of that agency to notify the architect. The co-operation of the local building authorities should also be constantly sought.

It is essential that a clear distinction be made between design, design details and construction before responsibility can be determined. For this reason, a brief statement of what comprises the service and duty of each agency is given in the following sections:

1. Municipal Approval and Inspection.—Municipal approval and inspection are a service rendered to the public to insure it that buildings shall be erected in conformity with zoning, occupancy, health, building code and other requirements laid down by public authority. Its scope may include, in some instances, investigation into features of design, but to completely check the design of each structure erected would exceed the working capacity of a municipal building department. It would require a staff of experts almost equal to the combined forces of private designers and would entail an expense and duplication of work too great for a municipality to bear. Field inspection also is limited by a like consideration of expense. Strict detailed field inspection would require an inspector constantly on each building, as a great amount of work may be executed in his absence. So far this has been an excellence of service which the building department's appropriation will not permit. Therefore, to ascertain whether an employe of the department is culpable because weaknesses of design or construction are incorporated in a structure, it is necessary to determine whether it was reasonably possible for him, considering the magnitude of his duties, to detect those weaknesses.

The function of the building inspector's force is analogous to that of the police force and it can be held responsible for infraction of building regulations in just so far as the police force can be held for infraction of other laws. In neither case should the full responsibility for the result of such infractions be shifted to the guardians of public authority.

2. Design and Supervision.—Design and supervision constitute the service rendered by an architect, or an architectural firm, to a client who is the owner. Unless otherwise agreed between these two parties, the former is obligated to execute a safe design; to supply adequate plans and specifications for estimating the cost and erecting the building, and to furnish supervision that will insure its erection in accordance with these instruments. This service may not include the drafting of detailed working drawings which are sometimes made by the contractor or a manufacturer, but it does include checking and approving such drawings regardless of their origin.

To insure that the owner's building shall be erected as specified, the architect should place on the work an inspector or superintendent. This supervision serves not only to safeguard the interests of the owner, but also, in public buildings, to insure the safety of the public. Even when the architect is confident of the constructor's skill and responsibility the failure to provide this supervision is a dangerous practice which cannot be too strongly condemned; and it is especially dangerous when adequate detail drawings and specifications are lacking. The contractor is not a designer, does not know the stresses which determine the design, and should have adequate supervision and consultation to execute the work as it is planned.

If any parts of the building, built in accordance with plans and specifications as either drawn or accepted by the architect, are found to be inadequate or improper, then he cannot avoid responsibility for the condition of such parts. Neither can he disclaim responsibility for violation of the plans and specifications, if laxity in supervision has made such violation possible; though in the latter case the agent of the violation should be held fully responsible for his own acts.

In so far as any portions of the Knickerbocker Theater, which were built as shown by the plans and specifications, are found to be a departure from the dictates of safe practice to that extent the design and supervision are responsible. In considering this matter, however, cognizance should be taken of an unusual circumstance involving design of the steel roof members. The fabricator, on account of difficulty in securing certain material, submitted an alternate design of his own, and this, it appears, was approved by the building department and accepted by the architect upon their approval. Adoption of this design obviously entailed responsibility to the owner for its safety, but, on the other hand, did not in any sense release the fabricator from responsibility for departures from safe practice.

As the details of structural steel fabrication are practically standardized, the responsible fabricators may usually be relied upon to execute a safe design for any given conditions. Many of them maintain thoroughly expert designers whose system of detailing and checking practically precludes an error. For this reason individual architects have placed in them a degree of confidence. But the steel design of the Knickerbocker contained serious departures from established practice, which are believed to have been a vital factor in the collapse, and while the architect may be culpable for not checking it, the fabricator, in whom he relied, cannot escape his moral responsibility for these departures. A tabulation of items showing departure from safe design is given elsewhere in the report.

3. Construction.—Construction, which is a service carried on under the supervision of an architect and performed by the general contractor, consists in furnishing materials and building the structure as shown by the architect's plans and specifications. It does not include design. However, it may occur that a sub-contractor seeks to change some feature of the design in order to simplify the construction or because certain materials are difficult to obtain. In that event he prepares a design, or such drawings, as may be required to show the alteration, and these must be accepted by the architect before any change or substitution is allowed. In such instances the sub-contractor obviously becomes an agent of the architect in supplying a design, as well as an agent of the general contractor in executing the work. For ultimate execution of the work, in accordance with the design, the contractor should be responsible, but for the adequacy of the alternate design he should share no responsibility.

The situation here cited occurred in constructing the Knickerbocker, and the design has been found inadequate, but it should be pointed out that unless the construction has varied from this design, or from other plans and the specifications, the contractor should not be held responsible except in so far as he may have been a party to an infraction of the law.

No evidence has so far been found to indicate that the building was not constructed in accordance with the plans and specifications, except that evidence given at the coroner's inquest indicates that the contractor added a reinforced concrete band running through the full length of the wall which carried the main truss, and strengthened the hollow tile under the truss support with concrete. This, it was testified, has been done because the wall seemed to the contractor to be of inadequate strength and in need of reinforcing. An examination of the wreckage indicates that the contractor used materials of suitable quality throughout the construction and that the workmanship was of a kind that should be expected in work of this nature. Several defects of workmanship have been found in the structure, but they appear to be of a minor character and not involved in the collapse.

In view of the evidence obtained by the committee's investigation, and by that of the coroner, no responsibility appears to rest upon the contractor by reason of the quality of his work or any non-compliance with the plans and specifications; but by conforming to these instruments, as required in his contract, which did not provide for anchoring trusses to the walls he was made a party to infraction of the building code. Under the Washington Code, which places responsibility for observance of its requirements upon "any person or persons, whether as principal agent or employe," it appears that violation thereof entails joint and several responsibility.

4. Ownership.—Ownership is charged in the erection of a building, and especially of a building used for public gatherings, with securing such design and supervision service as will insure its safety. It is the duty of ownership to insist upon adequate inspection and to pay a fee for architectural service sufficient to provide such inspection. If the owner presses his architect to reduce this fee below that commonly recognized as necessary to give adequate inspection he should not expect the building department to relieve him of responsibility for such action. Should the owner induce his architect to reduce the cost of structural design at the risk of endangering its safety, he jointly with the architect should share responsibility for the results.

In the case of the Knickerbocker, the architectural fee, as shown by evidence at the coroner's inquest, was lower than that advised by representative architects, and an examination of the building indicates that while the decorative features were elaborately executed, structural features were inadequately provided for. Whether any action of the owners resulted in this condition has not been determined, but if so, the ownership should share the responsibility.

Recommendations.—Investigation of the Knickerbocker disaster has forcefully emphasized four factors which have vital bearing upon the failure of this structure and which this committee believes should be called to the attention of owners, engineers, architects, contractors and public officials.

1. Building Approval and Inspection.—Under the present system of providing funds and administering municipal building departments it is seldom possible to fully check every design or to provide constant inspection of the work—the appropriation is too small. Expenses of the department are often drawn from the general tax funds, and thus place a burden upon all taxpayers, for services rendered for the most part to but a few. Under this system the department does not receive sufficient funds to render the service desired.

More extensive service could be provided if a charge, depending upon the value of a structure and sufficient to pay for checking design and for inspection, were made for each permit. This would place the cost of such service upon those who build, and would require from the general fund only an appropriation necessary to cover clerical and other general expense of the department. The cost of permits upon buildings used for public gathering could thus be made to provide whatever degree of inspection is advisable.

2. Design and Supervision.—The expense of designing, drafting plans and supervising the construction of a modern building are fairly well established, and the fees which must be charged an owner to cover the expense of this work and provide a reasonable profit, are fixed within rather narrow limits. These fees cannot be substantially reduced without lowering the character of service rendered. They are generally adhered to by representative men of the profession and are recognized as a reasonable minimum charge.

Some members of the profession, however, on account of strong competition in the architectural field and the tendency of owners to shop for professional service as they would for coal, will accept inadequate fees, and when they do are obliged to reduce the expense of design and supervision to such an extent that they are unable to furnish adequate supervision or complete plans, specifications and details. This condition forces the contractor, whose function is not to design, to construct the building without sufficient drawings as best he can. The safety of a structure may rest upon these details and failure of the designer to provide them constitutes a dangerous gap in his service. In the case of the Knickerbocker the plans and specifications were not complete, and testimony before the coroner showed that the inspection was inadequate.

In any building there are items of construction unforeseen by the designer which must later be added, but when, on a structure like the Knickerbocker, costing about $77,000, there are more than fifty such items, there would appear to have been incompetence, indifference, or both.

The committee recommends that the fees of architects and engineers be made sufficient to enable them to give competent and complete service. Fees recommended by the American Institute of Architects and the American Institute of Consulting Engineers are reasonable and proper and have had recognition by the courts.

3. Standardized Building Code.—Municipal building codes throughout the United States have generally developed independently by a process of accumulation, until it is now practically impossible for either an architect or a contractor to have cognizance of all the provisions in force in the various localities of his work. Many of those codes are deficient in vital particulars, to such an extent that an unsafe structure can be built without infraction of the regulations; for example, light and flimsy wall construction which in the Knickerbocker Theater was a weak element if not a direct cause of the collapse. A comprehensive and well-arranged code in any city would doubtless tend to reduce the possibility of disaster.

4. Registration of Architects, Engineers and Contractors.—Licensing of architects and engineers before they are permitted to practice has been advocated by various groups within these professions for some time, but the effectiveness of this requirement in preventing disasters seems questionable. Such a measure might merely limit the number of persons engaged in these professions.

What is needed is a method of fixing a greater responsibility for safe and legal work. The committee believes that this can be accomplished by requiring designers, and constructors as well, in all branches of building work, to seek registration with the building authorities before permits are issued to them. Such registration should be withheld if the applicant is unable to show his competency, responsibility and willingness to comply with legal requirements. In accepting the permit the registrant would further assume responsibility for the safety and adequacy of his design and for its execution in accordance with the conditions of the permit.

While the registration fee might be nominal, the penalty attached to violations of the permit should be sufficiently exacting to make the provisions effective. Cancellation of the permit and loss of the right to operate for a given period would doubtless prove effective. Registration of this kind would tend to restrict the planning and erection of building to those who are competent and responsible—a result that is greatly to be desired.

This committee recommends that engineers, architects, contractors and public officials be urged to advocate application of these recommendations, and, if necessary, the adoption by proper legislative bodies of laws putting them into effect.

Some Details.—The curved wall, which is the only one concerned in the roof failure, varied from 13 to 22 inches in thickness, but the main body of it was 18 inches thick, and composed of two thicknesses of 8-inch hollow tile with a space of about two inches between. On the street side of the wall was a facing of brick, stone or stucco approximately four inches thick, which under the Washington Code could not be considered as an integral part of the wall. The average height is slightly over 40 feet above the sidewalk.

The Columbia Road wall was found five inches out of plumb at the main bearing, shattered at the southwest corner where an auxiliary truss rested upon it, and cracked practi-

[illegible] in height at three other corners. These three cracks show in the brick and stone facing but it has not yet been ascertained whether they extend also through the tile. This wall pulled away from the stage wall about two inches at the top and pulled that wall apart about halfway between the stage and the Columbia Road wall.

The Columbia Road wall of the structure was not a safe wall for the heavy concentrated load placed upon it. It was approximately 40 feet high, 18 inches thick and not integrally bonded. About 45 per cent of its length was occupied by openings. Even a solid brick wall of this height and length would have required a minimum thickness of at least two feet to accord with good practice.

A rocker bearing was used on this wall to carry the heavy concentrated load of the main truss and no provision for anchorage was made. Such a bearing should have special consideration in its design to guard against the tendency to move sideways. The actual bearing surface was only six inches wide normal to the wall, and only a small movement of the wall or truss was necessary to cause unseating. The omission of anchorage was an infraction of the Washington Building Code.

The center of stresses of the lower chord and batter post at the north end of the main truss came on the edge of the wall bearing, giving about four inches of eccentricity. This caused additional stress in the chord which was not provided for.

(1) The roof slab was too thin for the load and length of span used, and while not a primary factor in the collapse, was a distinct departure from good practice and capable of producing a local failure.

(2) The stress sheet shows no provision made for the load or vibration of the double eight foot ventilating fan carried on the roof.

(3) The actual dead load of the roof as designed and constructed was about one-third more than the load which appears to have been used in computing stresses. This added greatly to the deflection of the main truss which was an important factor in the collapse.

Building Code Situation in United States

Some interesting figures on the building code solution in the United States were given by Dudley R. Holtman, Consulting Engineer, National Lumber Manufacturers' Association, in an address April 5 at the National Construction Conference at Chicago. Mr. Holtman stated:

There are 1,478 cities in this country with a population of 5,000 or more. Our information indicates that only 410, or 27 per cent, have a building law, and in all probability 20 or more of these laws are included as a part of the original city charter. Other cities claiming codes have what is merely a set of restrictions specifying the area known as the "fire limits." In the majority of cases, where fire limit restrictions only prevail, the ordinance merely specifies the area included within such limits and requires that the buildings erected therein shall have incombustible walls and roofs. They make no restrictions as to the allowable height of buildings. They say nothing about maximum areas between fire walls nor do they mention the character of interior construction. Any kind of a fire-trap interior may be constructed, and it may cover any area as long as the exterior walls are masonry walls and the roofs supposedly incombustible. In all probability these kinds of laws are the only ones in effect in 65 per cent of these 1,478 cities.

There are 259 cities with a population of over $25,000 and only 223, or 86 per cent, of these cities give evidence of having a building code. Thirteen of these cities have codes with no enforcing officer, while 23 cities have no code whatever but do have a building inspector.

Of the 460 cities with a population of from $10,000 to 25,000 only 116 or 25 per cent have a building law, and 26 of these have no officer to enforce it. Of the total of 739 cities with a population ranging between 5,000 and 10,000, only 81, or 11 per cent have building laws, and [illegible] of these cities have no means of enforcing the law.

A number of the cities which have codes have no copies available for the use of the public or for the use of builders and architects. Some of these regulations are hidden away in the minutes of the council meetings. A man who erects a building, or who has the supervision of the construction of a building in hand, must delve through musty records to determine what regulations he is expected to comply with.

Design Features of Concrete Arch Bridge at Winnipeg

The recently completed concrete arch bridge over the Assiniboine River at Maryland St., Winnipeg, Canada, provides for traffic between the business section and the best residential section. The deck, consisting of a roadway 50 ft. wide and two sidewalks each 7 ft. wide, provides for four lines of vehicular traffic, including street cars, with a maximum grade of 2 per cent. While this structure as a type of the standard barrel arch class of concrete bridge is not an object of special interest, the proportioning of its parts to form a harmonious whole and the mental processes involved in this proportioning are of considerable interest. An interesting account of these particular features is given by Mr. J. F. Greene, consulting engineer, in a recent issue of The Canadian Engineer, from which the matter following is taken.

The determination of the number of spans was not left to the designers. While comparative estimates disclosed the fact that a three-span bridge was slightly cheaper than a two-span structure, and while aesthetic precedent would demand three spans rather than two, the Department of Public Works objected to the location of the south pier in the navigation channel and intimated that only a two span bridge would be acceptable. The elevation of the crown of the south span was fixed as a result of the clearance set by the government for navigation purposes, hence the curves for the arches had been approximately predetermined, at least enough so to enable one to make preliminary sketches to ascertain how to treat most effectively the abutments, piers, spandrel walls and approaches.

Aesthetic Considerations.—A concrete bridge presents all exposed faces of one color, a dull monotonous gray. These faces in turn, disclose various irregularities, due to the method of constructing concrete structures; each lift, or day's run of concrete is distinctly outlined in any exposed concrete surface; board marks have distinctive entities of different shades of gray, some dark, some light, due probably to the absorption capacities of the several boards, and yielding of forms, no matter how slight, results in offsets or waves; occasionally rock pockets appear which must be covered by disappointing patches. All such appearances are irregularities, all are displeasing to the eye. It is incumbent upon the designers so to proportion the major members of the structure as to make it pleasing and dignified, while at the same time so to accentuate the minor members by the use of pilasters, inserts and grooves as to withdraw the attention from the essential defects of concrete surfaces.

It has been assumed as axiomatic that the dimensions and proportions of the several parts should be indicative of the service which each part contributes to the stability of the whole. The abutments, marking clearly the river banks and the limits of the arch spans, should appear to the observer as of sufficient mass to withstand successfully the horizontal thrust from the adjacent arch span. The pier, while of sufficient mass to carry the vertical loads transmitted from the arches, should present faces so proportioned as to offer the least obstruction to the passage of ice and water.

How the Illusion of Height Was Produced. With these limitations and axioms in mind, preliminary sketches were made. In one sketch an excessive use of horizontal lines, and in another an equally excessive use of vertical lines, disclosed the basis of the proper treatment for this structure. The structure outlined appeared to be squatty, this quality being exaggerated by the excessive use of horizontal lines and relieved greatly by the appearance of vertical lines. Proceeding from the assumption that the structure lacked depth, abutments and piers were increased in height to a level above that of the handrails, the surfaces were relieved with deep vertical grooves, and even the form boards were placed vertically to further the illusion of depth. The spandrel wall surfaces were broken up by pilasters which in turn were exaggerated by inserts at both edges to accentuate vertical shadow lines, contributing thereby to the depth illusion.

To conceal the results of yielding forms and outline of each day's run, grooves were left in the concrete at regular intervals, both in the arches and in the walls; with each day's run ending in a groove, the line of the joint was concealed and in addition the grooves themselves gave shadow lines which tended to relieve the monotony of the large flat gray surfaces.

In proportioning the exposed portions of the sidewalk slabs and brackets, it was expedient to exceed the structural requirements of the design, lest the parts should appear too light for stability. By breaking the sloping side faces of brackets into several vertical faces, an illusion of breadth and strength was produced and the impression which would have resulted from the monotonous succession of plain brackets altered to a definite and pleasing one.

Aesthetic Treatment of Deck.—This completes the consideration of the proportioning of these parts of the structure, which should appear to observers standing either upstream or downstream from the bridge. The treatment of the deck of the bridge presented a separate and a different problem. Smooth, easy approaches from connecting streets with the least possible grades attainable were desiderata. The elimination, or failing this, the subordination of all trolley and light poles on the deck of the bridge, was adopted as a policy which should be pressed consistently. The design of the handrail, the outstanding portion of the structure visible from the deck, remains. Since the observer views the handrail, not from a distance, as he views the arches, piers, and abutments, but at close range, the appeal to the imagination lies not so much in the tout ensemble, the grouping of the parts into a well balanced whole, as in the excellence of the parts themselves, the intricacy of the fabric and the quality of the texture. Hence it is essential that special methods of handling the concrete should be adopted so that the surface irregularities of commercial concrete, such as air holes, water holes, and form marks, would be eliminated. This may be accomplished in various ways, either by the dry process, or with sand moulds, or by scrubbing the surface of green concrete with steel brushes to expose a specially prepared color aggregate. On the Maryland bridge the third method was adopted; the colored aggregate consisting of red granite, crushed to pass a ¾-in. screen, was exposed by scrubbing with steel brushes and cleaned by several washings of muriatic acid and water.

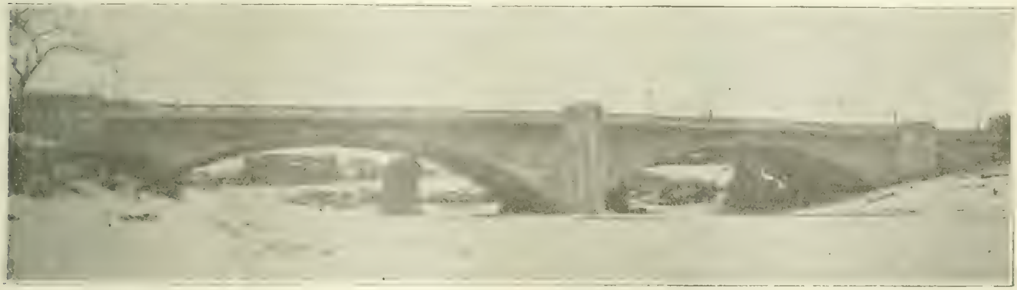


Fig. 1.—Reinforced Concrete Arch Bridge Over Assiniboine River at Maryland St., Winnipeg, Canada.

The illumination has been provided through the medium of four-light clusters, set on combination light and trolley poles, standing in the devil strip and located about 90 ft. apart. Each light is diffused by wide angle Holophone Refractors which reduce the glare materially; and the lights have been set high enough on the poles to eliminate dangerous shadows from passing cars.

Principal Structural Characteristics.—A consideration of the structural features may now be in order. The adoption of a solid barrel, earth filled arch, rather than an open, spandrel, reinforced, concrete deck bridge, rested primarily upon economic grounds and secondarily upon structural considerations. With an average fill of 10 ft. the earth fill arch showed a saving of 25 per cent under an open spandrel arch; on the approaches the saving was greater, since the increase in the cost of the deck was not offset by reduction in the substructure due to reduced dead loads. Further, the earth fill type, exposed only at the intrados, is less subject to movement and cracking due to extreme temperature changes than the open spandrel type. In addition the solid barrel type offered greater mass and at the same time less obstruction to the passage of ice.

In the design of the approach retaining walls, a radical departure from standard practice was made in that the foundations for these walls were carried down through more than 20 ft. of excavation, and bonded into the rock. This unusual treatment was due to exceptional conditions at the site. Just east of the north end of the bridge the Cornish baths had given evidence of a strong tendency to move toward the river, and a few hundred feet west of the bridge, several apartment blocks had actually moved and tilted; one section of one of these blocks had been condemned and demolished. The evidence was clear that the bank was not stable and that structures resting on this bank would be equally unstable; hence the reason for the unusual foundations for these approach walls.

Assumed Loadings.—Each arch was designed for a maximum live load of four 50-ton cars with an additional impact allowance of 20 per cent. The arches have been so proportioned that under all conditions of loading the line of resistance lies within the middle third, resulting in a maximum compression of 453 lb. per square inch. The maximum for combined live load, dead load, rib shortening, and a temperature drop of 60° is 652 lb. per square inch and for a temperature drop of 60° the maximum combined stress is 750 lb. per square inch. For tensile stresses due to rib shortening and temperature, steel reinforcement has been provided. Details of the arch ribs and spandrel walls are shown in Fig. 2. In general, 1-in. rods were lapped 5 ft. at splices and ¾-in rods were lapped 4 ft.

The structure rests upon solid rock foundations. The abutments were designed with the line of resistance within the middle third and with a maximum pressure upon the rock of 9¼ tons per square foot. The rock was excavated to a depth of 6 ft. to provide additional resistance to sliding. The maximum bearing pressure from the pier upon the rock is 11 tons.

The spandrel walls were designed as cantilevers resting upon the arches, the movement from the sidewalk brackets being transmitted through counterforts to the arch ribs. Expansion joints at the haunches provide for lateral movement resulting from the fall of the arches due to a drop in temperature, and at the third points expansion joints predetermine the cracks resulting from the rise of the arches due to a rise in temperature. All joints have been projected to the handrails and appear to be working satisfactorily; those at the junctions of the handrails with the piers and abutments have opened approximately ¾ in. at this writing. All joints in the walls and sidewalks have been sealed by folded strips of sheet lead to prevent the escape of water through the joints with the attendant discoloration of the concrete.

Proportioning of Concrete.—The engineering department had been instructed to use the gravel and rock provided by the Greater Winnipeg Water District at a price of $3.85 per cubic yard for gravel supplied during the winter, $3.00 per cubic yard for gravel furnished during the summer, and $4.00 per cubic yard for crushed rock. The problem, stated simply, was to determine the economical proportions of cement, sand, rock and water, combined to form concrete, which would give an assured compressive stress of 2,250 lb. per square inch at 28 days, i. e., three times the maximum stress in the arches. Preliminary investigations disclosed the fact that there were wide variations in the physical characteristics of different samples of gravel from the same pit. Tests of the gravel showed that the weights per cubic foot varied from 98 to 115 lb., and the percentage of content retained on a ¼-in. screen, ranged from 22 per cent to 45 per cent. Two series of tests were carried out, each comprising the making and breaking in the testing machine of 60 cylinders 6 in. in diameter and 12 in. long. In the first series, the lighter coarser gravel weighing approximately 105 lb. per cubic foot was used. The materials were combined in one group to make 1 part of cement to 6 parts of the aggregate, such as 1:1½:4½, 1:2:4, 1:2½:3½ and 1:3:3, and in another group to make 1:7½, such as 1:2½:5, 1:3:4½, 1:3½:4.

In the second series, while similar proportions were used, the gravel used was much heavier, weighing approximately 118 lb. per cubic foot. While no mechanical slump test for consistency was employed, the amount of water used was the least consistent with proper workability. The percentage of water for the first series varied from 6 to 8 per cent by weight of the cement and aggregate, and the water-cement ratio was from 0.85 to 0.96, by volume; for the second series the percentage of water varied from 7 per cent to 9 per cent and the water-cement ratio from 0.75 to 1.05.

Compression tests at 28 days showed that cylinders of the first series were approximately 25 per cent stronger than cylinders of the second series composed of the same proportions by volume. Since prudence would dictate that we should base our decision upon the tests of the weaker of the two series, we concluded that the most economical combination from which we might expect to get concrete of the desired compressive strength was 1 part of cement to 3 of gravel to 2½ of crushed rock, while the best results for the foundation concrete containing five sacks of cement to the yard were obtained with a combination of 1 of cement to 4 of gravel to 2 of rock. Complete records of the properties of the ingredients and of the concrete, were prepared and filed for reference.

Tests of Actual Concrete Used.—In order to obtain assurance that the concrete in the structure was of the quality anticipated as a result of the tests, sample cylinders made of the concrete actually placed, were taken daily and tested at 28 days. The concrete placed in the substructure, containing 5 sacks of cement per yard, was very dry, of a consistency such that it would just quake under tramping. The average of the tests run during the months of February, March and April for this class of concrete was 2,100 lb. per square inch, at 28 days. The concrete in the approach walls, containing 6 sacks of cement per yard, was wetter than the foundation concrete, but with only enough water to permit spading and consolidating the mass in the thin walls. The average of the tests for the class of concrete placed during May and June was 2,300 lb. per square inch. The concrete in the arches containing 6 sacks of cement per yard was of a consistency such that it would not flow, while at the same time containing sufficient water so that it would quake upon being tamped. The average of the tests for the concrete in the arches at 28 days was approximately 2,800 lb. per square inch. The importance of keeping the water content of the concrete at a minimum consistent with workability was emphasized and impressed upon the construction organization, with the result that we were able to obtain a result which more than equaled our anticipations. The increase in strength from 2,100 to 2,800 lb. per square inch for concrete with the same combinations of solids but of different consistencies is significant.

The [illegible] of the handrail was the result of cut and trial methods: sample slabs having been prepared of different combinations of the aggregates, these samples, after having been scrubbed and washed, were placed side by side and compared. The proportion adopted was 1 cement to 2½ broken red granite to 1 granite dust to 1½ torpedo sand.

Construction Methods.—The construction methods adopted for the work involved no spectacular operations. The prescribed task was the construction of the new bridge with a minimum of interference with the dense traffic over the steel bridge, the center line of which was west of the new bridge with the floors of the old and new bridges overlapping.

The substructure of the abutments and pier were constructed as units; the superstructure, including arches, walls, sidewalks and fill, was constructed in two parts, the east half of the bridge having been completed and thrown open for traffic before the wrecking of the steel bridge, and the commencement of construction upon the west half. This plan was adopted on the ground of economy, and because operations might be conducted under this method with the least interference with traffic.

The excavation of the abutments begun in December, was carried out with the usual derrick and skip or bucket equipment and was expensive owing to the cold weather. In preparing the foundations for the pier, an orange peel was used to remove a surface layer of rocks and boulders; a line of Wakefield sheet piling was driven from leads suspended from a derrick boom; this piling was backed by a puddle, the combination affording an adequate water-seal whereby the water was kept down within the dam with a single centrifugal pump. In excavation for the abutments and approach walls, sufficient water was encountered to necessitate the continuous operation of pumps.

The concrete plant for the foundations included a paving mixer with a side-loading hopper for which extension leads had been prepared. In concreting the pier, this mixer was placed on cribbing at an elevation high enough to permit of dumping direct from the mixer to the pier; the cement, gravel and rock, placed in the loading hopper with wheelbarrows at ground level, were elevated to the mixer over the extension leads. In concreting the abutments, the mixer was placed on the ground near the edge of the excavation, the aggregate placed in the side loader with wheelbarrows, and the concrete conveyed through chutes to place.

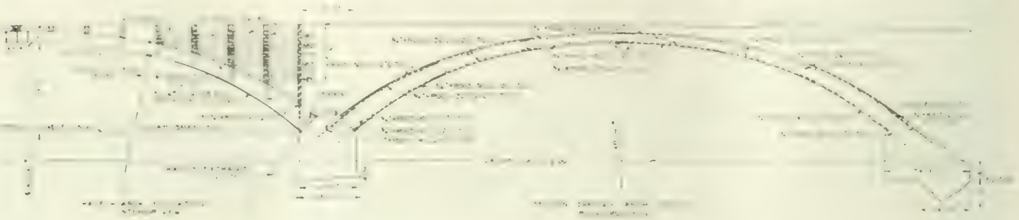


Fig. 2.—Details of Arch Ribs and Spandrel Walls of Maryland St. Bridge.

The water and aggregate for concrete placed during the cold weather were heated; the spaces containing concrete were housed and heated for a considerable period after the placing of the concrete; every effort was made to give the concrete the advantage of being cured under conditions approaching normal.

Arches and spandrels were painted with a waterproof paint to increase their emperviousness.

Concreting Plant.—The concrete plant for the superstructure consisted of a bin into which sand and rock were loaded from a bucket elevator, drawing from pits into which gravel and rock had been dumped, from heavy automobile trucks. This plant was so located in the west half of the north approach that it was possible to complete all concrete work without interference from the plant.

The concrete dumped from the mixer into side dump cars was drawn to place over a light wooden trestle by a small gasoline dinky, the engine for which had been taken from the mixer. In placing the concrete for the sidewalk and spandrel walls, concrete buggies were drawn to place by the dinky on flat cars made in part of the trucks from the side dump cars. The plant was cheap, eminently satisfactory, and the results were excellent.

The falsework was conventional, except perhaps, in the method employed to obtain the arch curve. In place of the standard practice of cutting the curves from the stringers, wedges and waste blocks and plans were added to build up the curves on plain stringers. Under this method much lumber otherwise worthless was used, and the stringers of new stock were available after use in a condition as good as that of new lumber.

Cinders for the fill were accumulated in an adjacent vacant lot during the first half of the year. These cinders were loaded into dump carts with a light electric Thew shovel and hauled to place on the bridge.

Construction began in December, 1920; the east half of the bridge was thrown open for traffic in August, the west half in November, and the street car traffic commenced on Dec. 1, 1921.

The contract for the construction was awarded to the City Engineer, W. P. Brereton, on a competitive basis, at a price of $250,000, and the bridge has been completed well within the contract price. The project was carried out with A. L. Cavanagh as superintendent; Allan Cotman, chief draftsman, and J. F. Greene as consulting engineer.

Insulation of Sound in Building

The demand for quiet rooms in hospitals, hotels and office buildings, the desirability of insulating music studios and other rooms where disturbing sounds are produced, and the necessity for solving other problems for the control of noise have led to repeated requests from architects and builders for reliable information on effective methods for insulating sound. A valuable bulletin on this subject has been published recently by the Engineering Experiment Station of the University of Illinois. In this publication, "Sound-Proof Partitions," the author, Prof. F. R. Watson of the university, presents the available information in a systematic way, giving the methods and results of various investigations relating to the action of materials on sound, describing practical installations of soundproofing, and setting forth in accordance with existing knowledge recommendations that may be applied where sound insulation is wanted.

Summary of Conclusions and Recommendations.—The information in the bulletin was drawn from three sources: the theory of the behavior of sound waves, experimental investigations of the effect of materials on sound, and examples of sound-proof installations. The details of this information, while drawn from different sources and apparently unrelated, co-ordinate in a satisfactory way in setting forth similar conclusions.

Some of the more general principles and recommendations in the bulletin are stated in the following paragraphs:

Sound may be transmitted from one side of a partition to the other in three ways; it may progress through continuous air passages, it may pass as an elastic wave through the solid structure of the partition, or, by setting the partition in vibration, it may originate sound waves on the further side.

These actions are quite readily understood by remembering that sound consists of a series of compressions and rarefactions that progress rapidly through a medium without interruption unless they meet a new medium with a different elasticity or density. For instance, sound waves in air proceed without hindrance through air passages, such as ventilation openings in a partition. If, however, the passages are small in cross-section, as in the case of a porous material, the progress is hindered and a certain amount of absorption of the energy takes place, due to the friction set up between the vibrating air column and the sides of the pores.

In case the partition is impervious to air, the direct progress of the waves is interrupted. A thin partition is set in vibration and thus originates new waves on the side opposite the incident sound. For a thicker, more rigid partition, the vibrations are smaller and a very considerable part of the energy is reflected. The transmission in this case takes place by compressional waves communicated to the solid material of the partition. The amount of energy thus transmitted is usually quite small.

In view of these considerations a sound-proof partition should be as rigid and free from air passages as possible. For effective soundproofing of a group of rooms, the partitions, floors and ceilings between adjacent rooms should be made continuous and rigid. Any necessary openings for pipes, ventilators, doors and windows should be placed in outside or corridor walls where a leakage of sound will be less objectionable.

In case the sound is generated in the building structure, as the vibrations set up by a motor fastened to the floor, the compressional waves proceed through the continuity of solid materials. In order to stop them, it is necessary to make a break in the structure so as to interpose a new medium differing in elasticity and density. For instance, the vibrations of a motor may be minimized by placing a layer of hairfelt, or similar air-filled material, between the supporting base and floor. Where the machine is quite heavy, footings may be made of alternate layers of asbestos, lead and leather. Bolting through this material will reduce the insulation, because the vibrations in this case will pass easily through the bolts to the floor. The insulation should thus be left without any bridging over of the discontinuities. Air gaps in masonry will be effective if the air space is not bridged over at any point. A floor floated on sand, sawdust, or hairfelt would approximate this condition. The edges of the floor should be insulated from the walls by felt or similar material.

Especial attention should be paid to the ventilation system. All effective sound-proof constructions either omit entirely a ventilation system or else construct it in some special manner to avoid transmission of sound. In some buildings air is supplied and withdrawn from rooms by individual pipes that are small in diameter and extend without break from the air supply chamber to the rooms. This results in considerable friction between the walls of the pipes and the air, with a resultant weakening of the sound waves. Without some efficient control of the transference of sound through the ventilation system it is a waste of effort to construct soundproof walls, double doors, and other contrivances for insulation.

When soundproofing a building all details should be considered with respect to the likelihood of transmission of sound. Each room, as far as possible, should be made an insulated unit by means of air spaces or air-filled materials that separate it from surrounding walls. Pipes and ventilators should be so installed as to minimize the chance of transfer of sound. Patent doors are now available that will close the door space at top, sides and bottom. In case a troublesome sound is generated in the room, it may be minimized by installing absorbing material on the walls.

The absorption of sound is an essential feature for soundproofing. Reflecting sound and scattering it still leaves it with energy. It must be absorbed; that is, converted into heat energy by friction, before it is eliminated as sound. This means that carpets, furniture, draperies, etc., sould be present, or if greater absorption is desired, hairfelt or similar materials must be installed.

The insulation of sound is a complex problem and a successful solution is obtained only when all the possibilities of transfer of sound are anticipated and guarded against. While many things may be learned from further experience and much may be gained from additional theory, enough has been revealed to give encouragement to the belief that soundproofing may be prescribed in the future with some of the certainty that now attends the acoustic design of auditoriums.

Corrosion of Chromium Steels.—It appears from the series of tests which the U. S. Bureau of Standards has carried out upon the corrosion of chromium steel that the behavior of the material when subjected to the acid test is not a sure criterion of its resistance to atmospheric corrosion. Of all the alloys examined, a high nickel-chromium steel, invar, pure iron, and medium carbon steel (very slowly cooled from a high temperature) were the most resistant to hydrochloric acid as measured by the loss of weight per unit area per day. High chromium steels (for example, 13.70 per cent Cr., 0.29 per cent C.) were found to be attacked by acid very much more readily. However, when the same specimens were subjected to a weathering test, consisting of a partial immersion in water and exposure to the air, the order of resistance was almost completely reversed. The high-chromium steels were the ones to withstand the treatment best, the low-chromium ones and the pure iron showing rust spots early in the test. The combination of both nickel and chromium appear to make the steel resistant to both acid and weather attack. In general, the steels which were quenched were found to resist corrosion better than the same material in the annealed state, but the differences found were much less than the differences resulting from composition changes, thus indicating that composition rather than treatment should receive primary consideration. Additional results will not be ready for some time.

Chuting vs. Wheeling in Placing Concrete

Factors Affecting Selection of Method, Outlined in Committee Report Feb. 15, Before Convention American Concrete Institute

The principal problem facing a contractor in the decision as to the type and kind of plant to use on a certain concrete structure is the choice of the means of placing concrete by means of wheeling or chuting. This decision once properly made, the other details of plant layout such as location of plant or arrangements for receiving material, may be properly determined by a similar method of analysis for either case.

The effectiveness of wheeling is limited chiefly by the distance which it may be necessary to wheel from the mixing plant.

Starting with the lowest cost for placing concrete in front of the mixer, the labor cost per cubic yard will rise with each addition to the haul.

Types of Chuting Plants.—Chuting plants are of two general types. The self-contained type, usually of about 100 ft. radius, is hung from the hoist tower by means of a suspended boom and counterweight chute. In the older or "line chute" method the chutes are suspended from a cable run between towers or between towers and anchorages.

The plant investment and installation cost, however, will vary with the distance to be spanned, for since the slope of the chutes with reference to the horizontal cannot be reduced below a certain fixed angle it follows that for long reaches there must be added to the cost of the extra length of chute a charge for the corresponding increase in the height of the tower.

Among other factors affecting the choice between the two methods of placing may be mentioned the character of the building; the cost of freight and repairs, the interest on investment and the kind of equipment which is available, as well as the amount of experience which local labor has had in concrete construction.

Chutes do not lend themselves as readily to all types of buildings, and it is here principally that the study is necessary. A nearly square structure is obviously best adapted for the 100 ft. radius type. The building should preferably have a high yardage or a number of stories, although "H" or irregular shaped buildings which may be enclosed in an approximate square can usually be handled as advantageously. Long narrow structures one or two stories high with low yardages are not adapted for this method of placing. With the same plan of building, but with greater yardage and more floors, one 100 ft. radius plant may be used to pour part of the building and by chuting to a floor hopper out 100 ft. off the wheel required to reach the rest of the building. Two independent 100 ft. radius plants may be used, or one mixing plant mounted on both towers.

Deciding Type of Plant.—The first step is to find out whether the job is one to which chutes will lend themselves without forcing. If by a general inspection of the conditions such is found to be the case, it is then proper to outline a plant layout for each method of placing and make an analysis of the advantages and disadvanatges of each.

The next step in the decision as to which type of plant is economical and suitable for a certain piece of work is to determine as accurately as possible the cost of each so that the one giving the lowest ultimate cost of mixing and placing concrete may be selected.

This ultimate cost may be separated for the purpose of analysis into the following items:

1. Rental of plant involved
2. Installations—labor and material
3. Maintenance of plant—labor and material
4. Operating cost of plant—labor and material

Analysis of Cost Items.—These four items will be explained more in detail as follows:

Item 1, rental of plant, is arrived at in several different ways by different contractors. The simplest, though not the most economical to the job, is to purchase suitable plant at the beginning of the work and sell it upon the completion of the job and the difference between the purchase and the sale price then represents the charge to be made as rental of plant. This method of handling plant has several disadvantages other than lack of economy, such as is the case in time of industrial expansion when suitable machinery might not be immediately available at the beginning of the work, or a period of depression at the end of a job making it impossible to dispose of the plant without a great sacrifice.

The usual way to handle this account is for a general contractor to maintain a suitable plant yard and charge each job a rental for the items of plant furnished to the work. The amount of rental depends upon the value of the machinery and the rapidity of its depreciation and varies generally from 5 per cent to 15 per cent per month of its initial value. Motors, engines, hoists, etc., with proper maintenance, will not depreciate in value more than 5 per cent a month. Mixers, boilers, etc., will depreciate 10 per cent per month and concrete carts, chutes and like items of plan will depreciate up to 15 per cent per month. Other smaller items, such as belting, shovels, wheelbarrows, etc., which are apt to be used up or destroyed during the life of an average job, are not generally considered as plant but as supplies and are bought by the job and any salvage value which they may have upon the completion of the work is credited to the part of the job for which they were purchased.

Where dealers are depended upon whose business it is to rent out plant and where this practice is followed, the average cost to the job is 10 per cent per month of the value of all machinery furnished.

The transportation of the plant including freight, trucking, loading and unloading, both and to from the job, is a proper part of the plant rental item.

Item 2, cost of installation, includes all charges for labor and material entering into the setting up of the machinery at the beginning of the work and includes the construction of storage bins, cement sheds, hoist towers, floor hoppers, run panels and such miscellaneous items as really form a part of the completed plant for mixing and depositing of concrete. This cost of installation also includes any additions to this plant or changes in the arrangement of the same which may be necessary during the operation of the job and also includes the cost of taking down the plant upon the completion of the work.

Item 3, maintenance, includes the cost of all labor and materials used in maintaining the plant in good working order such as repairs to bearings and other worn parts of machinery, painting and cleaning at the termination of work. To this item is also charged the cost of replacing parts broken during the life of the job.

Item 4, operating cost of the plant, is principally a labor charge, the only material entering into it being the cost of fuel, water, lubricating oils, waste, etc., and electric power in case electricity is used instead of steam. The labor in this item includes the actual operatives of the plant such as engineers, firemen, hoist runners, mechanics, etc., as well as the force of laborers employed in charging the mixer with the materials of concrete and the larger force of laborers employed in moving run panels or chutes, and those actually placing the concrete in the forms, whether it be by carryalls or chutes.

Effect of Labor and Speed Requirements in Plant Selection.—Serious shortage in the labor market or a necessity for extreme speed in placing concrete, may influence the choice of plant as normally selected. The actual value of these two conditions can generally be determined with sufficient accuracy so that a proper weight may be given to their influence in changing any layout of plant normally decided upon.

Principal among the items common to both wheeling and chuting systems will be:

Towers and guy lines.
Mixers.
Hoist drums.
Electric motors or steam engines and boilers and electric wiring or steam piping.
Concrete carts.
Floor hoppers, gates, etc.
Run panels with horses, etc.

In the case of a wheeling job large numbers of carryalls will be used, with their necessary run panels and supporting horses, sufficient to reach the most remote part of the works

There will probably be a single drum type of hoist used, and the hoist tower and floor hoppers will be built of wood. The size of the wheeling gangs must be determined for the whole job, as that sufficient to take care of a little more than the average haul, which will be half way from the tower to the most extreme part of the building. The charging and placing gang will remain about uniform throughout the job.

In case a chuting plant is decided upon, the special equipped will be as follows:

Steel tower, with base and head frame.

Siding frame, with hopper.

Boom and counterweight truss.

Extension chutes.

Special hoist bucket.

Intermediate hopper or additional siding frame and hopper.

It is seldom found feasible to chute to all the remote points of the building, and the increasing objection on the part of engineers to the direct placing of concrete in the forms from chutes will tend to the use of floor hoppers and a short haul by carryalls, with the resulting use of a smaller number of carryalls and floor panels, rather than the elimination of the same.

The charging and placing gang will be about the same as where chutes are not used. The actual operators of the plant, such as hoist runners, firemen, etc., will be about the same, whether the concrete be transported by chutes or by carryalls. The cost of power, whether steam or electricity, is considerably greater for the chuting than for the wheeling plant, due to the increased hoist necessary.

If due to special conditions, such as the necessary transportation of considerable quantities of concrete long distances, it is decided that line chutes are more suitable; the special equipment will consist of, principally:

Main hoist tower, generally of steel and greater height than for either of the other layouts.

Auxiliary towers or heavy anchorages.

Line chutes and heavy supporting cables.

Special auxiliary chutes, with gates, taking off from the line chutes.

Special hoist bucket.

Heavy guy lines and anchorages for towers.

Heavier hoist equipment.

Each Type of Plant.—The summary of the cost of each type of plant will shape up about as follows when all items are considered, it being understood that the specific items of equipment given below are only for an example.

I.—PLANT.

Wheeling. Equipment.	Depreciation.	Chuting. Equipment.	Depreciation.
Mixer, 1 yd.	20%	Mixer, 1 yd.	20%
Motor, 75 h.p.	20%	Motor, 75 h.p.	20%
Single drum hoist	20%	Double drum hoist	20%
100-ft. wood tower-ft. B. M. lumber at $ – per M.	100%	180-ft. steel tower	20%
Tower hoppers—ft. B. M. lumber at $— per M.	100%	1 additional sliding frame with 54 ft. straight back hopper	20%
Run panels and horses—ft. B. M. lumber at $— per M.	20%	600 ft. ¾-in. hoist cable	50%
1 yd. hoist bucket	50%	3,700 ft. ⅝ guy cable	50%
[illegible]50 ft. ¾-in. hoist cable at	50%	20 turnbuckles	
1,500 ft. ⅝ guy cable at	50%		
12 turnbuckles			
Wiring or piping	100%		
Concrete carts at	50%	Sliding frame with boom and counterweight truss plant complete	20%
		Blocks and tackle for boom	5%
		Blocks and tackle for truss	5%
		For moving sliding frame 1,080 ft. [illegible]-in. cable at	50%

Also includes bins, bulkheads, conveyors, elevators or other mechanical equipment forming part of set up. Usually these items will apply equally to wheeling and chuting plants.

Interest on investment at 7% .... months.

II.—INSTALLATION

Excavation for grading for mixer, plus sheeting and backfilling.

Setting up and dismantling motor, mixer and hoist.

Wheeling.	Chuting.
Building and dismantling wood tower	Erecting and dismantling steel tower, rigging, chutes
Making run panels and horses.	

Erection and dismantling of bins, bulkheads, conveyors, etc.

Electrical, plumbing and steamfitting work to connect up plant.

III.—MAINTENANCE.

Wheeling. Chuting.

IV.—[illegible]

Wheeling.

Fuel or power cost and waste.

Labor mixing, hoisting [illegible]

Men charging mixer.

Men handling cement.

Men on mixer.

Hoisting engineer.

Fireman (if any).

Man on tower hopper.

Men wheeling on floor. Men [illegible]

Men spreading and tamping.

Foreman.

Economics of Tenement Housing

Abstract of a Paper Presented Jan. 5, at the Am. Soc. C. E. Symposium on "The National Housing Problem"

By ANDREW J. THOMAS.

Whether one deals with the City of New York, or any other city, housing in tenements is the same.

Owing to the high cost of building in the last year or two, the writer has had occasion to study the economics of the situation more than in the past. Fig. 1 shows two plans which demonstrate what is meant by economics, bearing particularly on zoning, light, air and ventilation. These two plans occupy corner lots, 100 ft. by 100 ft. in size; they each have rooms of approximately the same size, and have 32 rooms to a floor, therefore they furnish an unusually good unit basis of comparison.

Plan A was adopted by the writer before the World War, and it is possibly the first of its kind designed and carried out in a constructed building in New York City. It was extensively copied and, therefore, it may be said to be a type plan in New York City. It covers 7,900 sq. ft. of building area on the 10,000 sq. ft. of the lot, or 79 per cent of the site. Plan B, however, covers only 6,200 sq. ft. (62 per cent), or 1,700 sq. ft. less than Plan A. Since both plans have the same number of rooms and the same rentable area, it is obvious that the 1,700 sq. ft. of excess floor area in Plan A over Plan B, may be looked on as wasted space.

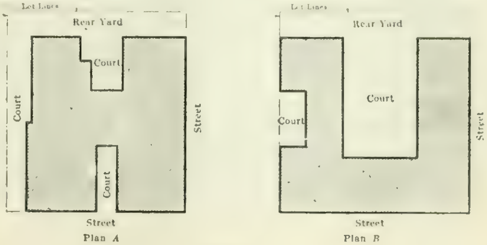


Fig. 1.

There are other points in favor of Plan B. Its rear rooms are lighted by a court, 37 ft. 6 in. wide, which width is regarded by the Tenement House Department of New York City as being almost a garden. In fact, it ceases to be a court. Plan A has courts only 12 ft. and 20 ft., approximately. How much finer is the light, air, ventilation and cross-ventilation and—the human factor, the livability—in Plan B than in Plan A! Furthermore, with Plan B the Tenement House Department has granted permission to remove the fire escapes from the street front of the building and to place them in the court, whereas the law states that any fire escape with exit leading to the street, shall be placed on the street. This street location of fire escape is a characteristic of Plan A. Because of the great width and the superior openness of Plan B, the authorities have granted the concession of placing the fire escape in the rear. To the writer this seems a great advance in housing planning, because it takes from the city streets the unsightly fire escapes which are an encroachment on the sidewalk and a detriment to real estate values.

The Building Loan Question.—A peculiar situation with regard to Plan B is that, after this saving in planning has been made, by sqeezing out of Plan A about 1,700 or 1,800 sq. ft., which means a saving of, approximately, $40,000 or $50,000, based on $0.40 per cu. ft. of cost, the financial interests in the City of New York will not lend as much money on Plan B as on Plan A, notwithstanding the greater economy of plan and construction of the former, and its far better conditions in respect to light, air and ventilation, and removal of fire escapes from the street. Plan B has the same, or perhaps a little greater, gross rental income, due to its better situated rooms, a $40,000 less construction cost, and a much lower maintenance and depreciation cost. It is a much better business proposition than Plan A, yet it is penalized on a loan.

After Plan B had been developed, the first man to come into the speaker's office was told of the new plan and what it could do for him. He said, "That is all right, if you can show me a saving of $40,000 in a structure of that sort, I shall be very glad to pay you $1,500 or $2,000 extra for your plan, but will the loaning interests give me the same amount on that plan as on the old one?" Without consideration, the writer replied, "Certainly, they will."

When the new client had gone, the writer began to realize that a building loan is appraised on a basis of the cubical contents of the building. The size of the mortgage is determined by taking a fixed percentage of the valuation of the building, as established by multiplying its cubical contents by a unit figure of building cost per cubic foot. Take, for example, the cubical contents of the two buildings represented by Plans A and B, for a building five stories high. It will be found that the loan on Plan B will be more than $20,000 less than on Plan A, regardless of its superiority in economy and desirability. The financial institutions place a premium on lost motion and waste space in a building.

When the writer discovered this unfortunate condition, he interviewed the heads of the loaning institutions and was told that they could not give the same consideration to the improved plan. When he expressed surprise at this, they told him that the only way they knew of appraising buildings was on the basis of full cubical contents.

Without exception, Plan A represents the future slum of New York. That little court, 12 ft. wide, is not adequate. It causes darkness, odors, dirt, rubbish, and other unsanitary and inflammatory conditions. Its greatest weakness, however, is in the matter of maintenance. Such a court is difficult to keep clean. Tenants, landlords and employees will allow dirt and rubbish to accumulate in the court or on the fire escapes, and, in the dim light, inspection is difficult. The experience of the City and Suburban Homes Co. of New York, which for many years has successfully housed about 10,000 wage earners at a rental lower than the speculative tenement builder can offer, is that narrow courts are so difficult to maintain that they are a weakness in a temement plan. Whereas, with wide courts, as in Plan B, housekeeping is exposed to the light, and to the public gaze, and fear of public opinion, if nothing else, induces cleanliness.

Plan A is the type fostered by many financial interests, owing to lack of knowledge of conditions of tenement housing. However, the writer has asked the New York Chapter of the American Institute of Architects for its support in upholding sound principles of appraisal. After several conferences the president of the chapter appointed a committee to discuss the matter of appraisal with the loaning institutions of New York City. This committee is now proceeding with its work, and is developing a model tenement for New York City.

Percentage of Lot Occupied by Building.—Another point remains to be considered in this complicated matter of tenement planning. This is the percentage of lot occupied by the building. In New York City, the law allows—together with zoning restrictions as to courts, which the writer feels are too lenient—70 per cent of the land to be occupied on interior plots and 90 per cent on corner plots. Until recently, the tendency on the part of investors has been to steer as close to the law as possible. Today, however, the laws and the building world recognize the necessity for economical construction and for admitting light, air, and ventilation into the building. Opinion differs now only as to how far land values permit such improvement. Outside of Manhattan Island, and on land costing $1,500 to $5,000 or more for a 25 ft. by 100 ft. lot, it is generally conceded that buildings are not economical when they occupy more than 50 per cent of the area. The writer designed a group of 4-story apartment buildings in Brooklyn, which occupy the end of a city block, 200 ft. along the avenue and 171 ft. along each street, and house 96 families in 3 and 4-room apartments. Each apartment has two or three exposures, almost like an individual country house, and overlooks, not a court, but an outdoor garden. This group of buildings occupies only 44 per cent of the lot area, and the owners calculate that it can be rented about 19 per cent cheaper than more congested types, like Plan A. The superiority of this Brooklyn group is due both to the more economical plan, and to much cheaper maintenance. The four buildings are operated by a force consisting of a superintendent, two men who tend the central heating plant in cold weather and work outdoors in warm weather, and three women who do cleaning. The buildings are kept clean without great effort, apparently. By merely taking a few steps from a point in the middle of the group, one can inspect every court and area and fire escape of the four buildings. In this case, bad housekeeping would be in the view of the public, and, consequently, does not appear. Easy maintenance, in which the co-operation of the tenants is induced by proper design rather than by irksome and expensive personal supervision by the management, causes less depreciation.

For the reasons of maintenance, together with high cost, due to excess space and to lost motion, the stereotyped apartment tends to become slums. It is too costly and, in addition, the owner, vainly struggling with the heavy depreciation, cannot rent his property at a figure high enough to allow for proper maintenance, and it is permitted to degenerate into slums. During the period of depreciation into a slum, the tenement is apt to pass through one or more foreclosures. Such is the history of many tenement properties.

Tenement house management is a business in itself, and the reason for its backwardness is that heavy depreciation is laid to carelessness of tenants, whereas careless planning of the building may be blamed. One can deal with slovenly tenants, but nothing can be done with an inefficient building. Defective plan arrangement promotes slovenliness in tenants.

As a result of a growing appreciation of the importance of these factors of maintenance and their relation to depreciation, the difference of opinion still existing resolves itself into the question of how far congested types of plan are necessary on the highest priced land, such as the crowded areas of Manhattan Island. The working classes, obviously, cannot be housed in high "elevator" structures, and the 5 or 6-story "walk-up" is their only salvation. The speaker has demonstrated, to his own satisfaction, that the maximum area that can be covered economically in interior lots is between 50 per cent and 60 per cent, and only a little more than 60 per cent on corners, very small frontages being disregarded in this comparison. Plan B covers 62 per cent, and has the same number of rooms of the same size as Plan A, which covers 79 per cent of the land, and it can be built for less money. One can still reduce the size of living rooms and bedrooms, and thereby increase the number of rooms, but not many more—and still keep them fit for human habitation. Satisfactory housing is impossible as long as bedrooms of the minimum legal size allowed in New York City are permitted. A bedroom 7 ft. wide, to accommodate two persons during hot weather, does not promote efficiency or happiness. The speaker feels that studies now being made prove that for those who can afford to live in new housing on expensive land, the most economical housing is in tenements covering from 50 to 60 per cent of the area of a 100 ft. by 100-ft. interior lot, which contain as many as 42 rooms per floor, in 3, 4, and 5-room apartments. The room sizes are naturally small, but may still be within the bounds of decency. Such a high number of rooms per floor, however, presupposes elimination of excess space and lost motion, such as is hardly ever attained in this class of planning. Even with 42 rooms per floor, 6 of them will face on a side court 6 ft. wide, along the party wall extending from street to rear yard, a condition which will give fairly good ventilation, but not much outlook.

Building Permits in 190 Cities Total $262,000,000 in March. Official returns for the month of March show 62,444 permits, with a valuation of $262,283,354. The returns for March, 1921, were $131,905,317. These last year returns were from the identical cities reporting this year, and it must be remembered that last year's total record for building was very good. The returns from 194 cities for January this year were $138,799,280, and the February returns from 188 cities gave a valuation of $139,919,847.

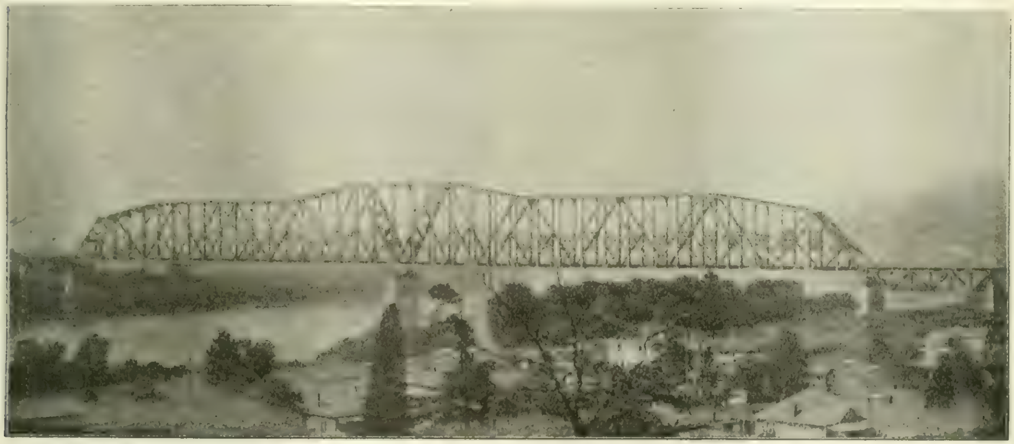
History and Characteristics of Continuous Truss Bridges*

By GUSTAV LINDENTHAL,

Consulting Engineer, New [illegible]

In view of the fact that the Sciotoville, O., bridge has the longest spans of the continuous truss type, and thus comes into competition, for long spans, particularly with the simple span and the cantilever type, it appears appropriate to review briefly its history and some of its characteristics not generally appreciated by American bridge engineers.

History.—The Britannia Bridge in England, built by Stephenson in 1848, marks a milestone in bridge construction, not only because it was the first important iron bridge of the beam type, but also because it was the first representative of the continuous girder type. It is a tubular plate girder bridge of four spans, two of which are 230 ft. and two of 460 ft. The girders were proportioned as simple beams, but the designer, realizing that continuity increased the carrying capacity, regarded this feature as an additional safety. To gain more information, he made tests with a model, and thus found the points of contraflexure of the elastic line, which he regarded as "fixed" and as dividing the span into two "cantilevers" and a "central beam." This laid the foundation for the later development of the modern cantilever bridge by the introduction of hinges at the points of contraflexure.



The Ohio River Bridge of C. & O. N. Ry. at Sciotoville, O., Completed in August, 1917; Continuous Truss Type, with Two 775 Ft. Spans.

Too much credit cannot be given to that galaxy of early English bridge engineers of nearly 100 years ago—Stephenson, Fairbairn, Telford, Tierney Clark—for the originality and daring of their plans and constructions. They did their own thinking; they did not wait for precedents, but created them. Theirs was the genius that originates as distinguished from routine which merely imitates.

The Britannia Bridge was followed by several similar bridges, among which may be mentioned the Torksey Bridge, built in 1849, over the Trent, with two spans of 130 ft., and the Bryne Bridge, built in 1855, with a central span of 267 ft. and two side spans of 141 ft. each.

In the latter part of the nineteenth century continuous truss bridges were extensively built on the Continent, principally in France, and were usually of the lattice truss type with parallel chords, with from three to five spans. The Fades Viaduct over the Sioule River, in France, built from 1905 to 1908, with a central span of 472 ft., was the longest continuous span previous to the building of the Sciotoville Bridge.

The Lachine Bridge, built in 1888, by the late C. Shaler Smith, over the St. Lawrence River, near Montreal, Que., Canada, with two side spans of 269 ft., and two middle spans of 408 ft., was, for 29 years, the only continuous bridge in America. It was built as a cantilever and then converted into a continuous truss for the live load. It was replaced in 1910 by a simple span bridge.

There has been always more or less prejudice against continuous trusses, because cantilever trusses offer the alleged more accurate computation of stresses on purely statical principles. No continuous girder as far as known has ever failed in the trusses, whereas the largest and most discreditable bridge failure belongs to the supposedly accurate cantilever type.

It appears now, however as if the continuous truss would again come into its own, for not only was it adopted for the Sciotoville Bridge, but also for the bridge of the Bessemer & Lake Erie R. R. built in 1918 over the Allegheny River near Pittsburgh, Pa., with spans of from 272 ft. to 520 ft., and for the bridge of the Hudson Bay Ry., across the Nelson River, built in 1918, with spans of 300 ft. and 400 ft.

Characteristics of Continuous Bridges.—The continuous truss type has nowhere met with more indiscriminate and unqualified condemnation than by engineers in the United States, who have alleged three principal objections against it, none of which is novel or decisive:

1st.—That it is statically indeterminate, that is, its reactions and stresses are dependent on the elasticity of its members;

2d.—That it is subject to stresses from unequal settlements of its supports; and,

3d.—That it is affected by temperature changes.

Although these characteristics may be objectionable in certain cases, it can be readily shown that they are entirely unobjectionable in others, and they will be briefly discussed.

Static Indeterminateness.—The argument that the stress computations are complicated can be readily dismissed. For preliminary and comparative designs, the simplifying assumption of constant moment of inertia of the vertical section through the girder or truss and the neglect of the elastic deformation of the web members, furnish sufficient accurate and quick results. For the final design, the slight additional time and labor involved in the accurate calculation is of no account since continuous bridges will never be a common type.

The stress calculation, of course, is the more complicated the greater the number of spans, but, for other reasons, it is not advisable to have more than three or four spans in a continuous bridge.

The fact that the stresses are, to a certain extent, dependent on the elastic deformation of the members, is characteristic of all statically indeterminate structures, but in a properly designed continuous bridge the effect of even large variations in the elastic behavior is insignificant when compared with other uncertain stresses, such as secondary stresses, etc., which exist also in statically determinate structures.

Variation between the actual and the calculated elastic deflections may be due, first, to a difference between the assumed and the actual modulus of elasticity, and, second, to the stiffness of the details, such as gussets, splice and tie-plates, rivets, etc., which can only be roughly estimated.

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*From a paper, "The Continuous Truss Bridge Over the Ohio River at Sciotoville, O., of the C. & O. N. Ry.," in the March Proceedings of the American Society of Civil Engineers, pp. 409-452

A proportional change in the modulus of elasticity or in the sectional area of all members due to allowance for details has no influence on the reactions and stresses, but only on deflections which change in the same proportion with the moduli.

The effect of non-proportional changes is well illustrated by a comparison of two sets of calculations made for the Sciotoville Bridge. It was planned that during the various stages of erection the trusses would pass successively through static conditions of a beam on two, three, four, and five supports. The calculations of the reactions, for the purpose of determining the necessary jacking forces at the temporary supports, and of the deflections, for determining the jacking heights, were made, first, on the basis of the gross area of the main section of the members without allowance for details and, second, on the basis of gross area of the main section plus the area of a section equivalent to 75 per cent of the weight of the details. The additional area, due to details, varies for different members from 5 to 25 per cent and averages about 20 per cent of the gross area of the main section. For these two extreme assumptions, certain deflections differ by 25 to 60 per cent, whereas the reactions differ by not more than 0.2 per cent in the two-span conditions, 465 ft.-775 ft., 10 per cent in the three-span condition, 155 ft.-465 ft.-775 ft., 60 per cent in the four-span condition, 155 ft.-155 ft.-465 ft.-775 ft., 11 per cent in the three-span condition, 310 ft.-465 ft.-775 ft., and 0.7 per cent in the final two-span condition, 775 ft.-775 ft.

The large differences in the reactions in the three and four-span conditions are due principally to the great variation in the length of the spans and to the comparatively great height of the short spans. Continuous trusses of great height and greatly different span lengths are, therefore, rightly objectionable, the more so, because they are also sensitive to settlements of the supports and to temperature changes. During erection, such a condition is of no consequence, because the reactions can be measured and the bearings promptly adjusted in height if necessary. Where the spans are more nearly equal, and the trusses not unusually high in comparison with the span length the effect on the reactions and stresses from a variation in the elasticity of the trusses is practically insignificant.

As a precaution and to obviate any uncertainty of stress action, from dead load at least, it is always possible and advisable, as was done in the case of the Sciotoville Bridge, to measure certain reactions, and, if necessary, to adjust the height of the bearings until the reactions are correct.

In no case should the variation in span length in a continuous truss be so great that the live load on any span will cause a reversal of the dead load reactions of the adjoining span. For all these reasons, continuous trusses over several spans and on metallic towers, or on steel arches, should preferably be shallow in depth, a rule first practiced by French engineers.

It is interesting to note that the actual deflections of the Sciotoville trusses, as observed in the field, were nearly midway between the values computed under the two previously mentioned assumptions; in other words, an average addition of about 10 per cent to the gross areas of the sections, to allow for details, should be made when calculating elastic deformations.

Effect of Settlements or Compressibility of Supports.—Where considerable settlements of the foundations are to be anticipated or where the supports are high elastic towers, the continuous type of bridge is not advisable, unless care is taken to eliminate the effect of inconstant levels by means of adjustable bearings.

The stresses caused by the ordinary compressibility of the supports can be computed and, if they are not unduly large, can be neglected or provision can be made in the sections.

Settlements of the foundations are less objectionable the longer the spans, as already mentioned. For similar continuous trusses with equal proportion of height to span length, the same settlement of a support causes stresses approximately in inverse proportion to the span length. Since settlements may be assumed as proportional to the foundation pressure and since the latter is about the same for long and short spans, under the same soil conditions, it follows that, in general, the danger of excessive stresses due to settlements is less the greater the span lengths. In special cases, it may be advisable to design the permanent details of the truss bearings on the piers and abutments so that they may be raised or lowered by hydraulic jacks at any time, as needed to maintain the original levels.

In the case of the Sciotoville Bridge, a settlement of 2 in. in one of the end piers, if it was possible, or a settlement of 1 in. in the middle pier, the others remaining undisturbed, would change the reactions by only 0.6 per cent. It is evident that even a considerably greater settlement, which would seriously disturb the vertical alignment of the track, would not objectionably affect the stress condition in the trusses. When the Kentucky end of the bridge was raised to its final position, after erection had been completed, difference in the jacking force for the last 3 in. of jacking was noticeable. This shows that for spans of this length continuous trusses are unobjectionable, even if the foundations do not rest on soil rock.

As already mentioned, the first continuous trusses had solid webs (Britannia Tunnel Bridge) and on the Continent small mesh lattice webs. The secondary stresses in the web are of no importance in the first type and, in the latter type, they may be considered rather beneficial, since they contribute to stiffness and absorb some of the bending stresses on the trusses, proven by the fact that the lattice can bear some load when the chords are cut away, only the chord sections over the bearings may need reinforcement against bending. In some instances, the continuous small mesh web girders over several spans were erected on falsework with a camber of 1/500 to 1/300 of the entire length of bridge and then let down on the pier bearings, to produce in the trusses initial bending stresses opposite those from live load. Such was the procedure of erection of the continuous truss viaduct of five spans on high iron towers over the Thur at Ossingen, Switzerland, in 1873. The writer was on the Engineering Staff for that structure, for which the statical computations were considered quite a feat at that time.

Temperature Effects.—Temperature stresses in continuous trusses may be caused, first, by the expansion or contraction of intermediate supports, particularly high steel towers, and, second, by unequal temperature changes in different parts of the trusses themselves (uniform temperature changes in all members cause no stresses).

The first effect is similar to that of settlement of the piers and is greater, the higher the intermediate supports and the shorter the spans. In some existing bridges, it amounts to as much as 25 per cent of the stresses from dead and live load. It is, however, insignificant and negligible in the case of long spans resting on shallow piers. As the stresses can be calculated, it is easy to make the necessary provision in the sections.

The second effect is neglected, as a rule, although in a case where the bottom chords are protected from the direct rays of the sun by a solid floor, the temperatures in the top and bottom chords may differ considerably. The effect of such a difference is similar to that of a variation in the elasticity of the truss members and may be serious in a case where the lengths of spans vary considerably.

In the case of the Sciotoville Bridge an average difference in temperature of 10° F. between the top and bottom chord (the effect of the web members is insignificant), would change the end reactions by only 1.5 per cent, which is negligible.

Summing up, one arrives at the well established conclusion that continuous trusses are generally unobjectionable under the following conditions:

1st.—Where the lengths of the spans do not vary greatly and the trusses are not unusually high as compared with the span length.

2d.—Where the foundations rest on fairly solid ground, compressibility of the soil being less objectionable the longer the spans.

3d.—Where the intermediate supports are not excessively high in comparison with the span length.

In every continuous truss there are a few members, such as the chords near the points of contraflexure, or web members near points of maximum moment, which are most sensitive to the effects enumerated, because their sections, as required by the dead and live load stresses, are comparatively small. Such members, as a rule, will require for fabrication or erection purposes a section somewhat in excess of that required by the stresses, to provide a certain margin for possible variation. It is advisable always to investigate such members and proportion them so that they are strong enough under reasonably extreme conditions.

Advantages of Continuous Trusses.—Again the disadvantages mentioned, as far as they can be considered as such in any given case, must be weighed the advantages which the continuous type possesses over the simple span or the cantilever.

As regards economy, it is not feasible to make a general comparison between the continuous bridge and the cantilever since that depends largely on the arrangement of the spans, which is usually governed by local conditions and of necessity must be different for the two types, owing to their different character. In comparison with a series of simple spans of the same length, however, the continuous truss shows a decided economy which is greater the longer the spans and, up to a certain limit, greater the number of spans. For long spans, the saving in cost may be as much as 25 per cent. For short spans, the economy over simple spans is not important, but greater rigidity under passing loads is an advantage.

In point of rigidity, as measured by the deflections, the continuous truss compares favorably with the simple span and shows a decided advantage over the cantilever. Its deflections and amplitude of vibrations are smaller, and the elastic line smoother and devoid of local kinks such as occurs at the hinges of cantilevers. Both rigidity and economy gain from the fact that truss members subject to reversion of stress (tension and compression) can be riveted members proportioned only for the larger stress.

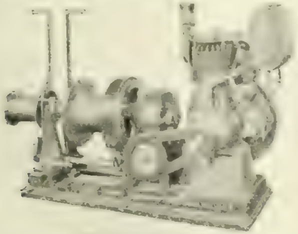
As is characteristic of all statically indeterminate structures, the continuous truss has the advantage in that when a member is seriously weakened, as may happen in the case of the derailment of a train and collision with the trusses, the probability of failure of the whole bridge is less than in the case of the statically determinate simple span or a cantilever. This greater safety is still more pronounced when the truss webs consist of small mesh lattice.

The continuous bridge presents no greater difficulties in erection than the cantilever, but it offers the advantage over the simple span in that it can be erected on the cantilever principle without, or with little, additional material. This was one of the governing factors in the case of the Sciotoville Bridge.

From the esthetic point of view the continuous bridge can well compete with the simple span or cantilever, if properly designed, but not with the more artistic arch or suspension bridge.

Worm Drive Hoist

A compact, self-contained, worm drive hoist is illustrated. Some of the advantages claimed for these hoists are: Worm drive prevents backward turning (with the clutch engaged) should the motor stop; a single reduction by worm and worm-wheel running in oil; few parts; all parts enclosed in a dust-tight and oil-tight housing; the whole driving mechanism: a rigid, compact, self-contained unit. The worm is of nickle-steel—hardened, ground and polished, and mounted on Gurney radio-thrust ball bearings. The clutch engaging mechanism is Silent Hoist patent design. The thrust is applied through large bronze triple square headed sleeves and is received by ball thrust bearings. The hoist illustrated has a lifting capacity of 1,500 lb. at 100 ft. per minute. Its drum is 15 in. long, 8 in. barrel diameter, and has a capacity for 1,000 ft. of $\frac{3}{8}$ in. cable. The engine is a 5 hp. New-Way. The overall dimensions of the hoist are 25 in. x 60 in., 29 in. high and the net weight is 1,100 lb. The hoist is made by the Silent Hoist Co., 302 McDougal street, Brooklyn, N. Y.



Model D-5 Hoist.

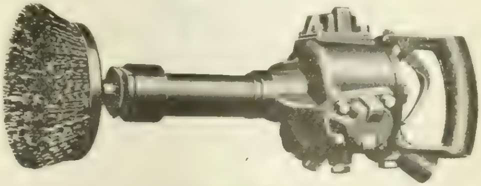
Wire Rope Cutter

A single device for cutting wire rope is illustrated. The body and base castings of this cutter are made of the very best grade of steel, and are guaranteed not to break. The cutter blade and lower cutting die are made of high carbon tool steel, properly tempered to insure long life and clean cut ropes. The stem of the body casting is made to fit the hardy hole of an anvil as well as its own base plate. The base plate is especially useful in splicing or when a rope is to be cut out on the job, as it eliminates the moving of the heavy anvil. The lower cutting die can be easily and quickly replaced if necessary. These dies have two cutting edges, so that when the edge on one side is dulled, it can be reversed. The device cuts all grades and sizes of wire hoisting ropes, haulage ropes, running ropes, oil well lines, etc., up to 1 in. diameter inclusive. This wire rope cutter is made by A. Leschen & Sons Rope Co., 5907 Kennerly Avenue, St. Louis, Mo.

Burch Wire Rope Cutter.

High Speed Wire Brush Cleaner for Cleaning Metal Surfaces

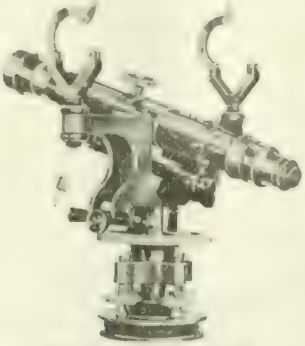
The Ingersoll-Rand Co., 11 Broadway, New York, has recently brought out a high speed cleaner known as the No. 601 "Little David" wire brush, which has a maximum speed of 4,200 r.p.m. This machine has been found very successful in operation, effectively cleaning metal surfaces and also iron and steel castings. On a six weeks tests this machine is stated to have cleaned steel gondolas, each averaging 540 sq. ft. surface, in 3½ hours. All-steel box cars each averaging 1,400 sq. ft. surface were cleaned in 7½ hours. The brush not only removed all the rust but the old paint as well so that when repainted the cars looked practically as if new sheets had been applied. The air motor is of the 3-cylinder type such as used in "Little David" portable grinder and which has been thoroughly tested out in the severe service to which pneumatic grinders are subjected. The machine is very simple in construction, is well balanced and operates without vibration. Light weight has been attained by using an aluminum casing reinforced with cast-in steel bushings. The weight of the complete machine is only 14 lbs. The average free speed at 90 lb. air pressure is 4,200 r.p.m. Length overall is 17½ in., diameter of wire brush, 6 in.



Little David Wire Brush.

Architects Convertible Level

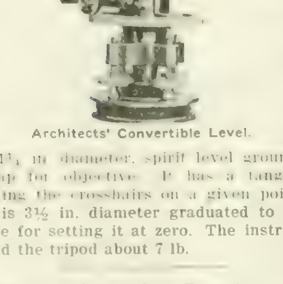
A new convertible architects' level designed for use on construction work has been brought out by the Pittsburg Instrument and Machine Co., 40 Water street, Pittsburg, Pa. This instrument can be used for sighting vertical lines. The arrangement for taking vertical sights is very rigid, the telescope resting on the strong leveling bar. The change can be made quickly and there are no detachable parts to get lost or misplaced. The telescope is 12 in. long, erecting eyepiece, object glass 1¼ in. diameter, spirit level ground and graduated, dust cap for objective. It has a tangent screw to facilitate setting the crosshairs on a given point. The horizontal circle is 3½ in. diameter graduated to half degrees; circle movable for setting it at zero. The instrument weighs about 7 lb. and the tripod about 7 lb.



Architects' Convertible Level.

Pneumatic Gun for Passing Rivets

A pneumatic gun for passing rivets from the forge to the holder on is illustrated. The gun consists of four parts, a compressed air tank, the head, metal tubing and a rivet receiver. The gun and the forge are conveniently located where they will not interfere with anybody; the tubing is then led to the job. As each rivet is heated and ready to be passed, it is set by the heater on a valve provided in an opening contained in the head of the gun. By its own weight, the rivet opens this valve and enters the machine. Automatically, the valve recloses and the rivet is prepared to be sent on its journey by a simple press of a foot treadle. This latter operation releases the compressed air, which has been supplied to the tank, into the head of the machine and speeds the hot rivet through the enclosed flexible tubing. The rivet is shot into the receiver at the other end, where the holder on easily removes and inserts it in the hole. The standard rivet gun has a distance capacity of 125 ft. and, it is stated, it will deliver rivets up or down at the rate of 50 ft. every three seconds. In actual operation, one of these guns is stated to have shot rivets 150 ft. in nine and a fraction seconds without subjecting the rivets to the slightest change in temperature. This apparatus is known as the Renflex Rivet Gun. It is made by the Pennsylvania Flexible Metallic Tubing Co., 201 North Broad street, Philadelphia, Pa.



Renflex Rivet Gun.

Building Costs Per Square Foot

In our March 22nd issue we gave the average costs per square foot of 8 different kinds of buildings as revealed by F. W. Dodge Co.'s statistics of contracts awarded in 27 states for the years 1919, 1920 and 1921. Herewith we reprint the same data with the addition of the average for each of the past 3 months:

	Cost per sq. ft.			1922		
Class of buildings.	1919	1920	1921	Jan.	Feb.	Mar.
[illegible]	[illegible]	[illegible]	[illegible]	$4.92	$6.26	$5.56
Educational	[illegible]	[illegible]	4.83	6.49	4.44	5.82
[illegible]	[illegible]	4.44	4.29	4.19	4.59	4.01
[illegible]	[illegible]	[illegible]	6.01	6.02	[illegible]	5.01
Hospitals, etc.	8.87	[illegible]	[illegible]	7.29	[illegible]	6.48
[illegible]	[illegible]	6.60	[illegible]	[illegible]	7.66	5.05
[illegible]	[illegible]	[illegible]	6.21	6.95	5.01	6.04
[illegible]	7.94	8.16	[illegible]	7.40	7.76	6.13
Average	[illegible]	$4.01	$4.01	$4.88	$5.10	$4.66

From these figures there is observable no indication that building costs have as yet entered a definite decline either in the aggregate or in any one of the classes here listed.

Industrial Notes

The Osgood Co., manufacturers of excavating machinery, Marion, O., is now working its plant full time, both day and night shifts.

Paul J. Kolman Co., manufacturers of steel reinforcing material, Chicago, has started the erection of a plant at Youngstown, O., the first unit of which will be 400x150 ft.

The Commercial Steel Castings Co., Marion, O., manufacturers of open hearth steel castings, owing to the increased demand of The Osgood Co. and other of its customers for steel castings, has let contracts for the erection of buildings and additions to its present plant which will enable it to double its output.

Harrison P. Reed, for many years electrical engineer and more recently head of the elevator department of The Cutler-Hammer Mfg. Co. of Milwaukee and New York, has been appointed general manager of the A. Kieckhefer Elevator Co. of Milwaukee. Mr. Reed is a graduate of the electrical engineering department of Cornell University, class of 1902, and has been a frequent contributor to engineering publications, recently having read a paper on "Electric Power Application to Passenger and Freight Elevators" before the American Institute of Electrical Engineers, of which he is a fellow. Mr. Reed has also been chairman of the Milwaukee Section of the A. I. E. E. He is a member of the Engineers' Society of Milwaukee. He will assume his new duties May 1.

The Crescent Sales & Mfg. Co., whose factory on South Clinton St., Chicago, was destroyed in the fire of March 15, has secured a new factory location and made arrangements for manufacturing. The offices of the company are located in the Westminster Bldg., Chicago, so that while the factory equipment was a total loss, the office records did not suffer. In addition to the waterproofing products manufactured by the Crescent Sales & Mfg. Co., a very active metal specialties department distributes building products throughout the middle west. The company represents exclusively the H. W. Covert Co., manufacturing Covert fireplace damper; the Cincinnati Fly Screen Co., manufacturing Cinnameo all metal rewireable metal frame screens and weather strips, and the Cincinnati Mfg. Co. line of hollow metal and kalomine doors, bronze grill work for banks and similar products. In the Chicago territory they are exclusive distributors of steel-crete metal lath.

Personals

C. R. Wright has resigned as port engineer of Hoaquim, Wash.

J. D. Whitfield has been elected city manager of Terrell, Tex.

Herbert M. Greene, Dallas, Tex., has been appointed architect of the University of Texas.

David M. Brucker, for the past two years assistant building inspector of Louisville, Ky., has been appointed city building inspector.

Frederic Bigelow, architect, has been appointed superintendent of buildings of Newark, N. J., succeeding William P. O'Rourke, who died recently.

Axel Carlson and **Curt Lundeen** have organized the Axel Carlson Co., People's Bank Bldg., Moline, Ill., and will engage in a general contracting business.

Maurice H. Maney, architect and builder, has been appointed city building commissioner of Boston, Mass., succeeding Herbert A. Wilson, who has been appointed police commissioner of Boston.

Leland G. Merrill has resigned as city engineer of Parkersburg, W. Va., to accept a position with the West Virginia State Highway Commission. He will be located in Division No. 3, under H. S. Snyder, division engineer, Parkersburg, W. Va.

F. W. Puette, Los Angeles, Calif., has been appointed by the Board of Public Utilities as assistant engineer in charge of telephone investigations of that city, to succeed George H. Rowe, who resigned to accept an engineering position with the State Railroad Commission.

G. Harold Edgell has been elected dean of the School of Architecture of Harvard University. Dean Edgell is 35 years old. He was graduated from Harvard in 1908 and has spent most of his time since then teaching fine arts at the university. From 1910 to 1912 he was fellow in renaissance studies at the American School of Classical Studies at Rome. He took the degree of Ph. D. at Harvard in 1913, became assistant professor in 1911 and has just been made an associate professor.

Obituaries

John M. Grant, a building contractor of Dallas, Tex., died last month at his home, 4217 Simpson St., aged 80 years.

Milton J. Ochs, head of the Ochs Construction Co., Allentown, Pa., died last month at his home, 1438 Hamilton Ave., aged 67.

Robert C. Boone, building contractor of Baltimore, Md., died suddenly at his home, 3820 Falls Road, aged 72. He is said to have built over 100 churches in Baltimore.

Roads and Streets Monthly Issue

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Managament and Office System

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Disgraceful Village Streets

There are 15,400 "incorporated places" in America. Of these 15,450 cities, towns and villages only 2,800 exceed a population of 2,500 people each; yet these 2,800 "urban places" contain 54,000,000 people, while 12,900 "rural places" contain 9,000,000 people. Nearly all the 9,000,000 residents of the 12,900 "rural places" live on unpaved streets, and the same holds true of a large percentage of the residents of "urban places." There are no statistics to show how many miles of streets there are in the 15,400 "incorporated places," so that we can not estimate accurately the percentage of unpaved streets.

Even without such statistics to indicate the extent of unpaved streets, it would be evident enough to anyone who travels much that most of our small towns are very inadequately paved. Mud half the year and dust the other half are characteristics of their streets.

When we grow unduly elated over our progress in paving our highways such facts as these should bring us to earth, yes, literally to earth—to the dirt streets, that are typical of most of our small towns and villages, and, also, of many of our larger cities.

We read repeatedly of overproduction in this, that or the other sort of industry. There are too many coal mines, too many iron furnaces and mills, too many motor car factories, too many textile mills, too many farms, too many stores, and so on through nearly every sort of productive and distributive business. It seems rarely to occur to anyone that such excess capacity of production exists solely because of failure to direct capital and labor into enterprises where there is an excess of latent demand over the present supply. By latent demand we mean potential demand, demand that may not exist at the present moment, but that can be easily aroused by proper educational and publicity efforts. There is unquestionably a great latent demand for better streets and roads, for most of our highways are not only a disgrace to us, but a very great economic burden, because of their disgraceful condition.

Is it not "up to" the civil engineers of America to lead the way in arousing the latent demand for improved highways? Are they not the logical propagandists of all economically needed public works?

We believe that most civil engineers would reply affirmatively, yet continue to act negatively. Money is needed both for economic investigation and for educational propaganda. Engineering societies have too little income even for their needs. How, then, shall they form public opinion when it costs much money to do so? The answer appears to be that engineering societies must solicit funds for such purposes from public-spirited men of wealth.

The Civil Engineer and Radio

The American indian is usually taciturn. From which it is perhaps inferable that talking is an art that does not reach perfection among races that live out of doors. Talking has been called the greatest of indoor sports. Certainly the tongue seems to attain its extremes of dexterous flexibility among peoples who abide much under a roof. Since women usually live more indoors than do men, we should expect to find them more addicted to lingual athletics than are men.

Having thus established at least a presumption that wordiness and indoorness go together, we are better able to understand why relatively few civil engineers are fluent talkers. The life of the average civil engineer, at least during his habit-forming years, is largely a life in the open. If this tends to make him diffident about trying to convey his knowledge to others, it has at least the merit of causing him to keep also his ignorance to himself. And what a worldful of ignorance is daily talked and printed.

There has been not a little worrying over the volume of printed matter that is annually produced. Already the literary accumulation is so vast as to daunt the student who seeks a broad education by reading. And now comes radio, with the promise (or is it not really a threat?) that the frozen language of a million authors shall be thawed from its print and caused to flow forth in spoken words to every corner of the world. Even the taciturn civil engineer in his quiet construction camp at night is to have lectures and sermons broadcasted upon him. Vanish for him the meditative hours, and in their stead the rattle and roar of talk, the tongue attacks of thousands of trained speakers. No more will future generations be able to say with truth

> Great teachers had I in my youth,
> The silent, speaking things of nature
> And solitude that taught me thought.

Is Reasoning Merely a Kind of Remembering?

By HALBERT P. GILLETTE, Editor

During the past 20 years there has been a growing tendency among educators to belittle the memorizing of facts and to exalt the cultivation of the reasoning powers. It seems not to have occurred to such educators that reasoning itself may be only a kind of remembering. Everyone grants, of course, that reasoning is impossible in the absence of memory, but this is by no means equivalent to regarding reasoning as a subclass of remembering. Yet, in the opinion of the writer such is the case.

In the commonest forms of deductive reasoning it can be readily seen that the inference or conclusion is nothing else than a remembered attribute looked for expectantly.

For example, when you infer that it probably will rain because of the presence of lowering clouds, you are doing nothing but expectantly remembering an effect (rain) that has usually followed under similar conditions. When you infer that a green strawberry will have a sour taste, your deductive inference is nothing but an expectant memory of the sour taste that every other green strawberry has produced when tasted. Similarly as to a host of everyday inferences, there is nothing more mysterious about them than there is about memory, for, in fact, they are expectant memories of class attributes that are vigorously aroused by perception of certain identifying class attributes in a given specimen.

Although it can be proved that this is true as to what may be called instinctive deductions, it may be argued that it does not hold true of deliberate or volitional deductions. A careful analysis of a very great variety of volitional deductions has satisfied me that they do not differ in essence from instinctive deductions. Volitional deductions differ from instinctive deductions only in the degree of hesitancy or deliberation involved.

When the mind moves to a conclusion with lightning rapidity, we call the inference by another name than inference, and thus conceal from ourselves its real nature. We call it "intuition" if it is the deductive inference of a man; and we call "instinct" if it is the deductive inference of an infant or an animal. But call it what we may it is nothing but an almost instantaneous exjectant memory of an attribute of a class of things. The memory may have been inherited or it may have been individually acquired, but in any case it has every one of the characteristics of memory, and no other characteristic.

When the mind moves more slowly to the conclusion that an unperceived attribute is about to present itself in a perceived thing, we call the process deduction. But I am unable to find a particle of outward or perceptible difference between such volitional or hesitant deduction and intuitive or instinctive deduction, other than the difference of time involved in the mental act. That there may be an inward or imperceptible difference, I grant. The brain-record by which volitional deduction occurs may differ from the brain-record by which intuitive deduction occurs; but the mental process that I am able to process is the same in both cases, differing only in rapidity.

Without writing a long article on this subject, it is impossible to show that every class of reasoning, even inventive reasoning, is a subclass or kind of memory. Yet such is the fact. Granting it to be so, some startling conclusions flow from it. For example, it follows that many of our educational methods are based on an incorrect theory, in that they slight memory, when, in fact, correctness of deduction depends on the breadth and accuracy of memory. It is commonly said, for example, that it is not necessary to memorize details, for they can be found in reference books and the like. But this argument overlooks several important things. First, that memory must be relied upon to know where to find the reference matter. Second, that the best of indexes is incomplete and usually very unsatisfactory to anyone who has a wide acquaintance with the sort of information that is desired. Third, that after the memory has guided the reasoner to a source of information, his memory must then be called upon to carry the facts thus found long enough to put them through the mill of his mind. Fourth, that in serving their greatest usefulness in that mental mill the new facts must call up old facts from the recesses of the brain, and that this can be effectively done only in a brain well stored with old facts.

I could add several other important reasons why the memory of facts is of vastly greater importance in reasoning than is commonly believed to be the case.

Probably the greatest aid to memory is classification of facts. Every brain instinctively classifies facts, but a scientifically trained brain carries classification much farther and with greater exactitude. A generalization is a statement of one or more attributes of a class. Hence it is important to remember many generalizations. But there are varying sizes of classes, from the very broad class to the very narrow subclass; and consequently there are many degrees of generalization from the broadest of principles to the narrowest. Who can tell us where to draw the line in our attempts to memorize generalizations or principles? Sometimes a very narrow principle is of exceeding economic importance when applied. Yet there are many teachers who teach that only broad general principles need be memorized. If they were to study the workings of the minds of a few successful business men, engineers and inventors, they might change their opinion as to the desirability of not memorizing narrow principles.

I am satisfied that one of the main reasons why so many college graduates cease to study much after graduation arises from the fact not only that they have been taught wrong theories as to the process of thinking but have become habituated to studying with interest only very general principles. How otherwise can be explained the relatively small sale of scientific books to college graduates? Is it not because they have been taught to rely on their own powers of solving each problem quickly when it arises without being taught to store their minds with facts and to work long in gathering facts to be applied in the solution of problems? When a new problem arises it usually presses for quick solution, and the average man grabs up a book or two, hurriedly runs through the very imperfect indexes, scans rapidly a few pages—and is off with the materials for the answer, if not indeed, with the final answer. That is about the way the average young engineering graduate, whom I have known goes at an economic problem that is assigned to him, unless it has an appearance of great difficulty. Unfortunately, most economic problems seem simple to the man who has not loaded his mind with facts relating to them. Hence the average young engineer regards the average new economic problem as being easy of solution, if only he will bring to bear his trained intellect upon it for a few hours. This is quite natural, for has he not been taught that all he needs remember is a relatively few general principles, that he must not burden his mind with details? Well, if he doesn't soon unlearn that sort of teaching he is probably doomed to failure. The highly successful engineer or inventor is usually a man whose mind is a marvelous store house of usable facts. Edison was fundamentally right in devising examination questions that would disclose the number of facts remembered by applicants for positions on his staff of inventors. Probably he erred in the exceedingly wide diversity of facts that he expected such applicants to remember, for many an excellent mind has a tenacious memory for only a limited class of facts.

In a later article I will explain how it is that even inventive reasoning is a subclass of remembering.

Ohio Roads Cost Less This Year.—The average cost per mile for all types of roads awarded by the Ohio State Highway Department during the first three months of this year was $27,500, as compared with $34,090, the average last year.

Letting of Wisconsin Road Contracts Well Advanced.—Up to April 1 last the Wisconsin Highway Commission had contracts from 225 miles of highway construction. On the same date last year 95 miles had been constructed.

A Comparison of Wholesale and Retail Price Levels

By JOHN CECIL BLACK, Editor

There is a common belief in this country that retail merchants are holding up their prices quite unwarrantably after wholesale prices have fallen, the fallacy of which is unmistakably shown in the accompanying table. Conclusions to be drawn from a study of these data are important, not merely in relieving the retailers as a class from an unjust charge, but as a further and very definite warning to those who still postpone purchases in the expectation of further price reductions; and in particular to any who, while granting that wholesale prices are not likely to go much lower, are still looking for the retailer to "come down to earth."

The index figures here used are all from the compilations of the U. S. Bureau of Labor Statistics. The somewhat peculiar and irregular time intervals between successive figures are due to the fact that the retail price index is available only for the times shown. We have here made all the comparison for which published data are available. In the case of food the indices are available for each month since January, 1920. The Bureau's wholesale price indices have been described in previous issues of Engineering and Contracting, and are printed each month in these columns generally in the last issue of the month. The retail price indices are from the Bureau's "Cost of Living Index," in which the various items are weighted according to the quantity consumed in the average workingman's family. Two other items, "Housing" and "Miscellaneous," are included in the cost of living index, but are omitted here because of the lack of wholesale prices of the same things.

INDEX PRICES.

	Food			Clothing			Fuel and lighting			Furniture and furnishing.		
	Wholesale.	Retail.	Difference	Wholesale.	Retail.	Difference.	Wholesale	Retail.	Difference	Wholesale	Retail.	Difference
Aver., 1913	100	100	0	100	100	0	100	100	0	100	100	0
Aver., 1914.	103	102	1	98	...	...	96	...	...	99	...	...
Dec., 1914..	105	105	0	96	101	—5	94	101	—7	99	104	—5
Aver., 1915.	104	101	3	100	...	...	93	...	...	99	...	...
Dec., 1915..	111	105	6	107	105	2	100	101	—1	99	111	—12
Aver., 1916.	126	114	12	128	...	...	119	...	...	115	...	...
Dec., 1916..	145	126	19	155	120	35	170	108	62	124	128	—4
Aver., 1917.	176	146	30	181	...	...	175	...	...	144	...	...
Dec., 1917..	185	157	28	202	149	53	158	124	34	155	151	4
Aver., 1918.	189	168	21	239	...	...	163	...	...	196	...	...
Dec., 1918..	210	187	23	250	205	45	171	148	23	227	224	3
June, 1919..	204	184	20	258	214	44	170	146	24	233	225	8
Aver., 1919.	210	186	24	261	...	...	173	...	...	236	...	...
Dec., 1919..	234	197	37	335	269	66	181	157	24	303	264	39
June, 1920..	279	219	60	335	288	47	246	172	74	362	293	69
Aver., 1920.	236	203	33	302	...	...	238	...	...	366	...	...
Dec., 1920..	172	178	—6	220	258	—38	236	195	41	346	285	61
May, 1921..	133	145	—12	181	223	—42	194	182	12	262	248	14
Sept., 1921.	146	153	—7	187	192	—5	178	181	—3	223	225	—2
Dec., 1921..	139	150	—11	185	184	1	187	181	6	218	218	0
Jan., 1922..	134	142	—8	183	...	...	183	...	...	214	...	...
Feb., 1922..	138	142	—4	183	...	...	183	...	...	213	...	...
Mar., 1922..	138	139	—1	...	...	...	...	...	...	...	...	...

The lag of retail prices behind wholesale is apparent enough, but instead of the approximate uniformity which some have supposed it to have it is subject to wide and significant variations. The minor changes up to the end of 1915 were roughly parallel, retail prices leading more often than following the wholesale. During the time of rapid rise beginning with the year 1916 and ending with the price peaks near the middle of 1920, retail prices with the exception of furniture lagged from 6 to 15 months behind wholesale. For example wholesale clothing reached a level of 202 in December, 1917, but it was a year later when retail clothing reached approximately the same level.

As shown in the table, retail prices in June, 1920, reached levels which had been attained by the corresponding wholesale prices from 6 to 12 months earlier; but the peaks of both wholesale and retail prices came at about this time, and the retail prices never got within many points of the wholesale maxima. In fact, those shown here ranged from 15 to 20 per cent lower.

In the liquidation following June, 1920, retail price levels failed to keep pace with the wholesale declines, and eventually were left slightly above wholesale levels. This condition, however, was temporary, and by December, 1921, food was the only group still showing retail levels in excess of wholesale.

To summarize, retail price levels were much below wholesale levels for 5 years from 1915 to 1920, and in some instances into 1921. Retail food and clothing rose above the wholesale levels in 1920 and 1921, but in amounts not nearly equalling the previous wholesale excesses, while at present, food, with a retail excess of 1 point, is the only group in which the lead is maintained.

While we have here only a part of the story of prices, and while no single individual can be judged solely in the light of general figures, it is evident that at least one set of charges of profiteering by the retail dealers have been unjust. Such observations should again remind us of the danger of hasty judgments or judgments based on hearsay and supposition. In fact, the thinking person must wonder how many cases of apparent dishonesty or unscrupulous practice are only apparent.

Methods of Gravel Road Maintenance in Canadian County

Practice in Elgin County, Ontario, Described in Paper at Last Annual Meeting, County Road Superintendent

By FRANK PINEO,

Road Superintendent, Elgin County, Ontario.

The maintenance of a roadway is the keeping of it as nearly as practicable in the same condition as it was when originally made; the repair of a roadway is the work rendered necessary to bring it up to its original condition after it has become deteriorated by neglect to maintain it. Thus there is a wide distinction between the two operations, and when the comparison of costs is instituted, errors are frequently caused by setting the repairs of one road against the maintenance of another or vice versa.

The crown of the road should be sufficient to allow water to pass freely to the ditches on the side of the roadways. On many of our gravel roads in Elgin County, the shoulders were higher than the center of the road. These have been thrown outward and either spread uniformly along the sides or drawn to some narrow or dangerous point on the road. Where the shoulders of the road are high, it makes impracticable the use of the most necessary implement for the maintenance of a gravel or earth road, the split log drag. After the shoulders have been thrown outward, the grader is then reversed, and if there is any good material, it may be drawn to the center of the road. Great care should be taken that no sods or poor, worn material is thrown into the center of an old gravel road. Resurfacing should be done with nothing but the best grade of screened gravel, well spread out, free from earth or any stones that will not pass through 1¾ in. ring.

In Elgin we have 256 miles of county road; of this mileage about 190 miles is graveled. Twenty-five is either macadam or stone road, and the balance is clay or sand. We own five gravel pits, these being located in different parts of the county with a view to trying, as near as possible, to furnish material for the entire county highways and not have the haul exceed more than 10 or 12 miles.

A semi-portable bin, elevators and screen are used for handling the gravel. The bin holds 30 tons; the floor or bottom has a slope of about 50 degrees, so that the gravel will slide to the opening or chutes on the side of the bin. The gravel screen is 9 ft. long, all in one piece with 3 ft. perforated with ¼-in. holes for sand, 3 ft. blank to carry gravel across the bin which is 12 ft. wide, and 3 ft. of one and ¾-in. holes. The elevator is of the bucket type 32 ft. long with hopper at the bottom. Gravel is brought from the bank with the ordinary slush or slip scraper drawn by a horse and dumped into the hopper, the horse passing directly over the hopper which is protected by grizzy bars.

A regular gang of men are employed in this work during working months. They are furnished with portable cook house, sleeping tents, etc., this equipment taking care of the whole gang, including the truck drivers. We handle from 125 to 160 tons of gravel per day.

Teamsters usually haul about 1½ yd. to the load and the orders given them are to make four dumps of this size load and spread it at least 10 ft. wide. In this manner one load of gravel will cover about 10 ft. of road in length. Our trucks are of the dump body type carrying a load of 5 yd. This size of load will cover about 200 ft. of road in length 6 ft. wide. In some cases three widths of gravel are put in by the trucks, making a spread 18 ft. wide.

A gravel road is very apt to break up during the early spring but it is only a matter of a few days if properly attended to at the right time, for it to come back to its original shape. An emergency of this kind should be provided for by having storage gravel piled alongside of the road.

I have found that the early spring is the proper time to go over our gravel roads and shape them for the coming summer. Where a gravel road is inclined to be wavy our method for leveling is to use the standard size grader, turn the blade crosswise and plane the unevenness down in this way. This can be done in the early spring. If we find the road bed too hard for the blade we remove it and attach a scarifier on the grader where the blade has been. After the roads have been shaped in this manner the ordinary split log drag will keep them in a fair condition for the balance of the summer, providing that enough shifting material is on the road which is quite necessary in order to maintain a gravel road.

Gravel should never be placed on an old gravel road more than 2 in. in depth. Never get so much gravel on the road in one place that the traffic will not continue to pass right over it. Use the traffic to roll out your road instead of a road roller. A patrolman should be appointed about every 2½ miles, and he should be furnished with a split log drag or small grader. I am not in favor of too much mileage for one man. Get the right kind of man interested, farmer preferred, who will have a little time after a rain, which is the proper time to scrape the road, and in this manner the whole system can be gone over in a few hours. And if you find a man neglecting his road, get rid of him.

New Specifications of Illinois Highway Department for Road Oils

By H. F. CLEMMER,

Engineer of Tests, Illinois Highway Division

The ever-increasing use of road oils in the State of Illinois has prompted a considerable amount of laboratory investigation and practical research, the results of which have done much to enable the highway department to prepare its new set of road oil specifications. As a great many factors have bearing upon the satisfactory use of these oils, specifications covering the quality of the material have in the past been only a means of rejecting the poorest of grades. The present specifications are expected to do considerable in bringing about the oiling of roads to a better advantage insofar as economy and service are concerned.

The oiling of roads in this state has passed the embryonic stage where the expense and results are not to be considered. In 1921 there were 7,000 miles of roads oiled in Illinois at a total cost of approximately $1,500,000. Over 25,000,000 gal. of road oil was used in this work. The cost of this material amounted to about 5 ct. per gallon delivered, with the cost of application amounting to 1 ct. per gallon. The average cost of oiling a mile of road in 1921 ran between $200 and $250.

Increasing public interest in oiled roads has created a demand for more information relative to the best methods of applying oil, the comparative merits of different kinds of oil, and the types of oil to be used on various kinds of soils. The great lack of uniformity in applying oil to roads has been the subject of considerable discussion for some time and investigation in this, as well as other problems relating to the use of oil are wanted. The Illinois Highway Division has recognized this want and has made considerable progress in the investigational field. A far greater number of experiments are now being planned and will be executed within a short time. The University of Illinois has also come to the same conclusions and consequently is planning extensive investigation in road oils. Under the direction of the Engineering Experiment Station a 12-mile experimental road is now being constructed upon which various problems attending the oiling of roads will be solved.

During the past few years the Laboratory of the Division of Highways has tested several thousand samples of road oil and has collected much valuable information regarding the quality of oils from various sources and results obtained from their use under various conditions existing in Illinois. The activities of the laboratory through its testing and work in preparing specifications has had the result of gradually improving, both in respect to uniformity and quality, the oils which are being used in this state. The most noteworthy feature of present road oil practice in Illinois is the tendency toward the use of heavier oils. A few years ago practically all oil used contained between 40 and 50 per cent asphaltum, heavy oils being considered unsafe or unsatisfactory to use. Figures compiled by the laboratory show that during 1921 70 per cent of all oil used in the state was purchased to contain 50 to 60 per cent asphaltum, 16.5 per cent to contain more than 60 per cent asphaltum, and only 13 per cent to contain less than 50 per cent. Recognizing this condition, the laboratory has prepared the following specifications and it is probable that practically all oil purchased in the state during this season will be purchased under these or very similar specifications:

SPECIFICATIONS FOR OIL FOR EARTH ROADS

SPECIFICATIONS E-1

General.

(These specifications admit Mexican and similar asphaltic base petroleum residuums. Semi-asphaltic base petroleum when refined by certain processes may yield residuums meeting with these specifications.)

Chemical and Physical Characteristics.

1. The road oil shall be homogeneous and free from water. It shall meet the following requirements:
2. Specific gravity 25°/25° C. (77°/77° F.), not less than 0.930.
3. Specific viscosity at 40° C. (104° F.), 25.0 to 75.0.
4. Loss at 163° C. (325° F.), 5 hours, not more than 25.0%.
5. Total bitumen, not less than 99.5%.
6. Per cent of total bitumen insoluble in 86° B. naphtha, 7.0 to 18.0.
7. Flash point, not less than 80° C. (170° F.).
8. Per cent of residue at 100 penetration, 50 to 60.

SPECIFICATIONS E-2

General.

(These specifications admit petroleum residuums refined from petroleum from Texas, Louisiana, Oklahoma, Kansas, Illinois and other semi-asphaltic petroleums. Oils meeting the requirements of Specifications E-1 will be acceptable under Specifications E-2.)

Chemical and Physical Characteristics.

1. The road oil shall be homogeneous and free from water. It shall meet the following requirements:
2. Specific gravity at 25°/25° C. (77°/77° F.), not less than 0.900.
3. Specific viscosity at 40° C. (104° F.), 25.0 to 75.0.
4. Total bitumen (solubility in carbon disulphide), not less than 99.5%.
5. Per cent of residue at 100 penetration, 50 to 60.
6. Flash point, not less than 80° C. (175° F.).

SPECIFICATIONS E-3

General.

(These specifications admit either asphaltic base or semi-asphaltic base petroleum residuums of a heavier grade than covered by Specifications E-1 and E-2.)

1. The road oil shall be homogeneous and free from water. It shall conform to the following requirements:
2. Specific gravity at 25°/25° C. (77°/77° F.), not less than 0.930.
3. Specific viscosity at 100° C. (212° F.), 20 to 60.
4. Total bitumen, not less than 99.5%.
5. Per cent of residue at 100 penetration, 60 to 70.

Tests of the physical and chemical properties of the road oil shall be made in accordance with the following methods:

1. Specific gravity, U. S. Dept. of Agriculture Bulletin 949, Test No. 19, p. 26.
2. Specific viscosity, U. S. Dept. of Agriculture Bulletin 949, Test No. 27, p. 44.
3. Loss on heating, A. S. T. M. Standards, 1921, Serial Designation D6-20, p. 731.
4. Total bitumen (solubility in carbon disulphide), U. S. Dept. of Agriculture Bulletin 949, Test No. 20, p. 38.
5. Naphtha solubility, U. S. Dept. of Agriculture, Bulletin 949, Test No. 22, p. 40.
6. Flash point, U. S. Dept. of Agriculture, Bulletin 949, Test No. 24, p. 42.
7. Percentage of solid residue of 100 penetration, U. S. Dept. of Agriculture Bulletin 949, Test No. 28, p. 45.

Specifications E-1 and E-2 may be considered as alternate specifications covering oil for cold application or which would require only slight heating. Specifications E-3 admit oil of a somewhat heavier grade than covered by the E-1 and E-2 specifications. This grade is best suited for hot application on soils of a somewhat sandy nature or on roads which have been previously treated with a lighter oil.

Analysis of Motor Vehicle Traffic on Connecticut Highways

Digest of Report of Bureau of Public Roads on Traffic Censuses Conducted Last Year

During August and October, 1921, the Connecticut Highway Department, in co-operation with the Bureau of Public Roads, conducted traffic censuses on two of the principal highways of Connecticut. The purposes of the censuses were to determine the economic value of the highway, the classification of vehicular traffic; the gross weight and wheel loads of motor trucks and the extent of overloading; a basis for the distribution of construction and maintenance costs; density of traffic; width of vehicles and the relation of density and width of vehicles to roadway width; the movement of freight by highway; the speed of vehicles and to serve as a basis for a formulation of traffic regulations.

Time and Scope of the Censuses.—The first census was taken during the last two weeks of August on the Hartford-Springfield road at the Massachusetts-Connecticut State line. The second census took place during October on the Boston Post road at the town of Greenwich, Conn. Each of the censuses covered a period of 14 days. The daily survey covered 10 hours, rotated so as to determine the traffic movement at the earlier and later periods of the day. Two night counts were conducted to form the basis for an estimate of night traffic. Road scales were installed on both roads to weigh the traffic as it passes over the road. At the Greenwich station a 49,000 lb. automatic Fairbanks scale was used in order to delay the traffic as little as possible.

During the first census traffic bound south from Springfield, Mass., to Hartford, Conn., was weighed whether empty or loaded. North bound trucks were stopped but only commodity information was obtained. The density of traffic was such that it was impossible to weigh trucks going in both directions. In the second census the east bound traffic from New York was weighed and west bound trucks were stopped only for commodity information. The personnel of the survey included eight men to handle both truck and passenger car traffic. During the second census older men were employed and the results, especially the truck information, were more accurately recorded. Traffic was only slightly delayed by the observers, and drivers co-operated willingly when they understood the purpose for which the information was asked.

During the first census the information, including the weight of the truck, was obtained in an average of 1 minute and 41 seconds, the longest time being 2 minutes and 55 seconds and the shortest 1 minute. At different times during the census speed tests were made and one of the results of the survey is the indication that a more accurate index of truck speed can be obtained at a place a few miles from the traffic station where drivers will not suspect that the test is being made.

Five forms were devised for use in recording the data.

The cost of the first census was $1,693.10, of which $977.63 was for the scale, $170 for the cost of erecting it, and the balance for salaries of the observers. The cost of the second census was $3,331, of which $2,700 was for the scale and the balance for salaries of observers, etc.

Passenger Traffic Analysis.—Twenty-eight thousand and eleven passenger cars were recorded during the first census and for 14,036 of the cars observed the records were analyzed to determine the average haul, number of passengers, etc. In the second census 38,566 passenger cars were recorded and the records of 5,023 were analyzed.

The number of motorcycles and horse-drawn vehicles was so small in comparison with passenger cars and truck traffic that their numbers are not reported.

All makes of cars and all types, including touring cars, roadsters, and other special types were observed during the census.

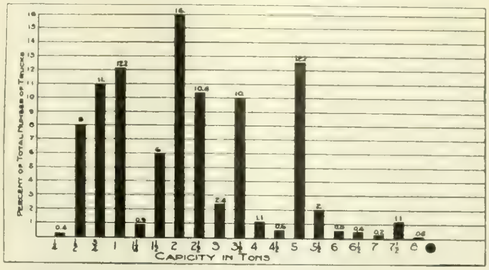
Forty-four thousand nine hundred and fifty passengers were transported in the observed cars, south bound, in the first census. An average of 3.2 passengers per car. During the first census of the licenses observed 50.5 per cent of the total were Massachusetts tags; 34.9 per cent were Connecticut; 7.2 per cent were New York, and 7.2 per cent were miscellaneous.

The location of the census taken near the Massachusetts-Connecticut State line and the fact that this analysis relates to south bound traffic accounts for the high percentage of Massachusetts cars.

In the second census the average number of passengers per car was found to be 3.311. The analysis of license tags shows Connecticut with 53.1 per cent; New York, 37.4 per cent; Massachusetts, 3.2 per cent; New Jersey, 3.2 per cent. A daily average of 6,739 passenger cars was found for the two censuses while the daily truck average was 792.

The principal movement occurred between 7 o'clock in the morning and 8 o'clock in the evening, the peak load occurring at 5 p. m. The hourly density of truck movement from 8 p. m. to 5 a. m. indicates the night movement of regular truck lines. During this interval an average of 13 trucks passed over the roads per hour.

In the first census the daily average of passenger car movement for 24 hours was 2,907. The average mileage per car was 70.018 at 3.2 passengers per car, and figuring the value of the passenger service rendered at the railroad rate of 3.6 ct. per mile the passenger service on the Hartford-Springfield road during the two weeks was valued at $327,595.50.



Composition of Truck Traffic on Boston Post Road, Connecticut.

During the second census the daily average of passenger car movement for 24 hours was 3832.4. The average mileage was 52.4. Computing the value of the service as above the value for the two-week interval was $355,417.04. On the two roads together the value of the service rendered for a year would be $17,238,326. This figure is merely the value of the service rendered by these two roads estimating the value at railroad rates. It is not the cost of the service rendered by the roads.

Truck Overloading.—The truck weight data from both censuses was analyzed to determine the wheel and axle loads and to ascertain what percentage of the vehicles weighed in excess of the legal limitation of 25,000 lbs., and what part of the traffic consisted of vehicles with wheel loads greater than 800 lb. per inch of tire width, and what proportion of the vehicles were overloaded when gauged by the capacity rating of the manufacturers. The latter practice is referred to as overloading per capacity. The weight standard used in determining overloads for each make and capacity consists of a summation of the manufacturer's 1920 weights for the chassis, body, and rated capacity, giving the total weight when loaded to rated capacity. The percentage distribution of weight recommended by the manufacturers of trucks for front and rear axle load was used as a standard for computing overloads on the front and rear axle. To be conservative, 5 per cent of the total chassis, body and capacity weight was added to the manufacturer's given weight in deriving the standard for computing overloads. One-half of this 5 per cent was added to the front and rear axle weights in arriving at a standard for measuring overloads per axle.

Commodities Overloaded.—The practice of overloading per capacity is not confined to loads of heavy material, such as sand, gravel, brick, etc.

It is restricted to no typical group of commodities, but is almost universal.

Apples, beer, butter and eggs, drugs, fish, furniture, groceries, lumber, meat products, paper, rubber goods, sugar, vegetables, wire are typical commodities of which overloads per capacity were noted.

Of the cases of overloading per capacity observed, 75 per cent was practiced by regular trucking vehicles, 25 per cent by irregular trucks.

Commodity loads exceeding 25,000 lb. were noted in the case of such commodities as brick, butter, drugs, eggs, glass, groceries, litharge, meat, plumbing supplies, sugar, vegetables and vinegar.

Of the number of loads exceeding 25,000 lb. 87.8 per cent were overloads per capacity; 88.7 per cent were by regular trucking companies. Thirty-nine out of 41 cases were loaded from 846 to 1,500 lb. per inch of tire width on the rear axle.

Composition of Truck Traffic.—Only 4.2 per cent of the trucks observed were over 5-ton capacity. The percentages of other capacities noted were as follows:

Capacity in tons	Per cent of total number	Capacity in tons	Per cent of total number
[illegible]	0.4	[illegible]	1.1
[illegible]	[illegible]	[illegible]	0.6
[illegible]	[illegible]	[illegible]	12.7
[illegible]	[illegible]	[illegible]	2.0
[illegible]	[illegible]	[illegible]	0.5
[illegible]	[illegible]	[illegible]	0.4
[illegible]	16.0	[illegible]	0.2
[illegible]	[illegible]	[illegible]	1.1
[illegible]	[illegible]	[illegible]	0.06
[illegible]	[illegible]		

Width of Truck Body.—The least width of truck body observed in the two censuses was 5 ft., the greatest width in either census was 9 ft. 6 in. Only 6 per cent of all trucks observed in the first census and 5 per cent in the second census were equipped with bodies exceeding 7 ft. 6 in. in width.

Classification of Truck Weight by Type of Tire.—Pneumatic tires were observed in use principally on the lighter trucks; solid tires on the heavier trucks and a combination of pneumatic and solid on the rear and front wheels respectively principally in the weight classification from 3,000 to 14,000 gross weight in pounds. The use of pneumatic tires increases rapidly from 2,000 to 5,000 lb. and then decreases rapidly to 10,000 lb. The number in excess of 10,000 lb. is negligible. The greatest percentage of trucks equipped with pneumatics occurs in the 4,000 to 5,000 lb. class. Solid tires begin to increase rapidly at 5,000 lb.

Classification by Weight of Trucks.—The density of movement was found to be between the 4,000 and 14,000 lb. classes, 1,378 out of 2,183 observed trucks falling in these classes. Only 51 out of 2,183 or 2.3 per cent exceeded 25,000 lb. Only 7 out of 2,183 weighed more than 28,000 lb.

Truck Weights Per Inch of Tire Width.—In the first census 29 of 226 trucks, 12.8 per cent, were found to have front axle loads in excess of 800 lb. per inch of tire width.

One hundred and thirty-eight out of 359, 38.44 per cent, were found to have rear axle loads in excess of 800 lb. per inch of tire.

One hundred and sixty-seven of 585, or 28.55 per cent, were loaded to more than 800 lb. per inch of tire width on both axles.

Overloads on the front axle range from 800 to 1,100 lb. per inch, density occurring at 900 lb.

Overloads on the rear axle range from 800 to 1,650 lb. per inch, density occurring at 1,100 lb.

In the second census the per cent and range of overloads were as follows:

Front axle — 11 per cent, 800 to [illegible]; density, 950 lb.
Rear axle — [illegible] per cent, 800 to [illegible]; density, 1,100 lb.
Both axles — [illegible] per cent.

In both censuses the number of overloads increases as tire thickness increases to 1½ in. and decreases above that thickness.

Truck Overloading Per Capacity.—The weighted average overload per capacity computed on basis of standard defined on page 54 is 39 per cent. This is construed to mean that every third truck was loaded beyond the capacity of the truck and tires. A total of 37.5 per cent were overloaded on the rear axle, and 40 per cent were overloaded on the front axle.

Recommendations Based on Overloading Analysis.—(1) Classification of highways. (2) seasonal restriction of loads. (3) prohibition of overloads per capacity, and restriction of tire to 800 lb. per inch width. (4) maximum body width of 7 ft. 6 in. (5) maximum axle loads to be determined for each season and class of trucks and placed in conspicuous place on the vehicle.

Commodity Analysis.—The 20 commodities noted in greatest bulk in the second census with the weight and average haul of each are as follows:

Commodity	Weight in pounds	Average haul in miles.
Groceries	1,039,469	44.15
Furniture	573,545	71.47
Beer	421,665	72.92
Sugar	404,640	47.26
Household goods	375,495	99.81
Meat products	334,410	12.75
Rubber goods	279,020	82.96
Vegetables	176,893	37.68
Poultry	169,760	32.67
Cocoa beans	168,518	33.12
Merchandise	153,831	42.88
Wire	145,550	66.50
Grapes	141,220	48.56
Bananas	133,627	47.13
Dry goods	133,360	43.79
Feed	131,140	27.10
Silks	125,305	110.22
Lumber	119,805	35.51
Machinery	115,875	89.10
Litharge	111,570	106.25

The longest average hauls reported were those of boats and yeast, each of which was hauled an average distance of 150 miles. The volume of these commodities hauled were: Boats, 840 lb.; yeast, 10,445 lb.

The shortest haul reported was that of charcoal, 2,150 lb., of which were hauled an average distance of 3.50 miles. The next shortest haul was milk, 4,725 lb., of which were hauled an average of 5.80 miles.

Agricultural products make up only 14.3 per cent of the traffic in the second census; manufactures and miscellaneous, 72.5 per cent, indicating, according to the report, that truck movement in Connecticut is predominantly that of manufactured goods of high value and small bulk.

Because the survey was limited to one season all agricultural products are not represented in the list of commodities.

The average haul of agricultural commodities is 39.5 miles; the longest, eggs, is 68.21 miles.

Extending observed weights and hauls during the period of the second census it is estimated that the annual ton-mileage of agricultural commodities is 86,649.

Estimated value of agricultural products hauled both ways over Boston Post Road at Greenwich, based on observations of the second census, $15,075,000.

Comparison of Truck and Railroad Traffic.—Comparing the truck traffic observed in the second census with traffic over the New York, New Haven & Hartford and Boston & Maine railroads, the results are as follows:

	By Truck	By N. Y. N. H. & H. (1918).	By Boston & Maine (1920).
Products of Agriculture	14.3	9.4	11.8
Products of Animals	11.2	3.3	3.2
Products of Mines	0.7	42.5	36.8
Products of Forests	[illegible]	6.5	13.2
Manufacturers and Miscellaneous	72.5	38.3	35.0

Total observed east-bound truck traffic, second census, 239,562 ton-miles.

Adjusted to give 24-hour traffic for the 2-week period, 360,000 ton-miles, east bound.

Seventy-one per cent of east-bound traffic loaded.

Thirty-six per cent of west-bound traffic loaded.

Estimated traffic both ways for 2-week period, 540,000 ton-miles.

Assuming this traffic to be average for year the annual East and West movement at Greenwich is estimated at 14,040,000 ton-miles of pay freight.

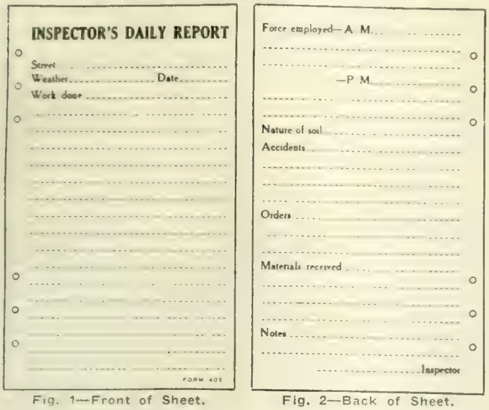
The average haul of truck movements was 47.44 miles.

Lower Road Costs in Wisconsin.—A list of highway construction costs, compiled by H. J. Kuelling, Construction Engineer of the Wisconsin Highway Commission, shows a reduction of $8,953 a mile in the 12-month period from April 1, 1921, to April 1, 1922. The 1921 average for an 18-ft. concrete road, exclusive of surveys and inspection, was $34,336 a mile. The 1922 cost is $25,383 a mile. Concrete surfacing, which cost an average of $2.77 a square yard last year, now costs $2.05, a decrease of 26 per cent. Grading, which cost $1.17 a cubic yard last year, now averages 81 cts. a cubic yard, a drop of 31 per cent.

Wages of Wisconsin Patrolmen 20 Per Cent Lower.—The wages of the 1,800 patrolmen who maintain the trunk highway system of Wisconsin are 20 per cent lower this year than the 1921 scale; the average scale is now about $140 per month.

A Daily Report System for Asphalt Paving Inspection

Engineers charged with the responsibility for the construction of public work many times find themselves unable, because of various inroads on their time, to visit the individual jobs as frequently as the work really requires. This means either neglect of the work or the installation of some system of "distant control" as an electrical engineer would term it. Fortunately a very complete system of such control requires only a small expenditure of time, energy or money; in fact, a well devised and strictly enforced system of "daily reports" properly used will satisfy all demands. For the past three years the Bureau of Engineering of Binghamton, N. Y., has been using a system of daily reports in connection with its construction work. The following brief description of the system as applied to asphalt construction has been prepared by W. Earl Weller, City Engineer of Binghamton, and published by the Asphalt Association in a circular:



INSPECTOR'S DAILY REPORT

Street

Weather .... Date

Work done

FORM 401

Force employed—A M.

—P M.

Nature of soil

Accidents

Orders

Materials received

Notes

.................Inspector

Fig. 1—Front of Sheet. Fig. 2—Back of Sheet.

Inspector's Daily Report Form.

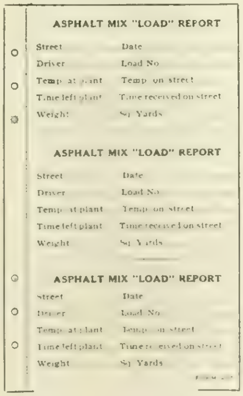
The daily report has long been the ever-present help of engineers occupying executive positions in private corporations, but the tendency, unfortunately, in public work has been to dismiss the report as a useless bit of red tape. In reality a system of daily reports has three distinct values. First—The necessity of preparing a daily report that will be read has a decided effect in holding an inspector closer to his job. Second—When the work is complete the daily reports form an invaluable record of the job. The profession of contracting has its share of constituent members having such common human failings as inefficiency and dishonesty. Sooner or later every engineer will meet a contractor endowed with one or both of these failings. At such a time the record comes into its own and demonstrates its worth. Third—Daily reports, received and considered not later than the morning of the day following the one covered by the report, keep the engineer in touch with the work each day no matter how the individual jobs may be scattered, thus making it possible for him to follow the progress of the work, to check the ability of his inspectors and to determine just where the time at his disposal for visiting the work shall be spent. This last is "distant control."

No type of construction work lends itself so readily to such control as the asphalt pavement and municipal engineers who have spent weary hours either searching for or trying to develop capable asphalt inspectors will add, perhaps, that no type of construction work stands so much in need of such control.

Inspection at Asphalt Plant.—Whenever asphalt work is in progress in Binghamton at least one inspector is on duty at the plant. This inspector is required to file a daily report including certain specific and certain general information regarding the day's run. For instance, he is required to take at hourly intervals the temperature of the asphaltic cement in the melting kettles and to note these temperatures in his report. He also notes on his initial report the mixing formula used by the contractor and on subsequent reports indicates any change in this formula. Two other items of specific information must be furnished by the plant inspector on each daily report, the total run of the plant in tons and a statement of all materials received. He is at liberty, in fact is encouraged, to report any item of general interest in regard to the plant operation, such as the force employed, accidents to employes or to the plant and general observations concerning operating efficiency. He must report back to the office on his daily report any orders which he may have received during the day. This feature of the report has been especially valuable both in fixing responsibility and in assuring the engineer in charge that his instructions are understood. All this information is recorded on Form 402 (see Figs. 1 and 2). This report must be filed in the City Engineer's office not later than 9 o'clock in the morning of the following day. In addition to the things the plant inspector must do in order to render a satisfactory report he also takes samples of all materials received and makes such simple plant tests as may be required to keep the mix fairly uniform. At times it has been found advisable to have two inspectors at the plant, one spending all his time on the mixing platform. The samples taken by the inspector include a daily sample of the asphaltic cement taken the first thing each morning from the kettles.

Every load of "mix" leaving the plant must be accompanied by a consecutively numbered load report (see Fig. 3) signed by the plant inspector. These reports are made in triplicate by the inspector who notes thereon the number, destination, temperature and weight of the load and the time it left the plant. One of these reports is given to the driver of the truck or wagon, the second is given to the plant foreman and the third is retained by the inspector. When the load arrives on the street the driver must deliver to the city inspector on the street his copy of the load report. The temperature of the mix is again taken and, if this temperature is satisfactory, the load is dumped. The inspector then notes on the copy of the load report given him by the driver the temperature as determined on the street, the time the load was received and roughly the number of square yards the load was made to cover. The plant inspector sends his copies of the load reports to the office with his daily report and the street inspector does the same with the copies that he has received from the drivers.

Street Inspection.—The street inspector is required to submit a daily report covering the work done, the force employed and the materials received on the job. The work done must be so described that, should it be necessary, the work of any half day can be located both on the street and in the plant reports. This result is obtained by describing the work by stations which have been chalked on the curb at regular and frequent intervals by the engineer in charge and by designating by load numbers the mix used in each section. The street inspector is also required to show on his report a fairly close estimate of the yardage of top placed during each half day and to give, as in the case of the plant inspector, a brief synopsis of any and all orders that he may



ASPHALT MIX "LOAD" REPORT

Street Date

Driver Load No

Temp at plant Temp on street

Time left plant Time received on street

Weight Sq Yards

ASPHALT MIX "LOAD" REPORT

Street Date

Driver Load No

Temp at plant Temp on street

Time left plant Time received on street

Weight Sq Yards

ASPHALT MIX "LOAD" REPORT

Street Date

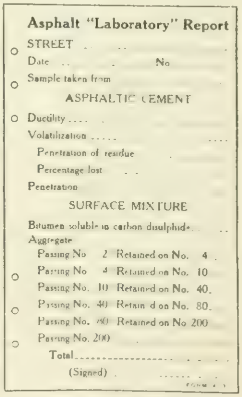
Driver Load No

Temp at plant Temp on street

Time left plant Time received on street

Weight Sq Yards

Fig. 3—Load Report Form.



Asphalt "Laboratory" Report

STREET

Date No

Sample taken from

ASPHALTIC CEMENT

Ductility

Volatilization

Penetration of residue

Percentage lost

Penetration

SURFACE MIXTURE

Bitumen soluble in carbon disulphide

Aggregate

Passing No 2 Retained on No. 4

Passing No 4 Retained on No. 10

Passing No. 10 Retained on No. 40.

Passing No. 40 Retained on No. 80.

Passing No. 80 Retained on No 200

Passing No. 200

Total

(Signed)

Fig. 4—Laboratory Report Form.

report. He is also required to take at least two samples each day of the mixture as received on the street and to record very carefully the exact locations in the street and the numbers of the loads from which these samples were taken. The daily reports of the street inspector must be filed in the City Engineer's office not later than 9 o'clock of the morning following the day covered by that report.

The samples of the asphaltic cement and of the surface mixture as taken by the inspector are delivered by the engineer in charge of the work to the City Chemist for analysis. These analyses are made immediately and the results reported to the City Engineer on the "Asphalt Laboratory Report" (See Fig. 4).

Handling the Reports in the Office.—In the office the load reports from the plant are checked against the load reports from the street and then destroyed. The load reports from the street are then considered, temperatures being noted first. Any load leaving the plant too hot or received on the street too cold is listed for comment. The tonnage for the day is compiled next and checked against the daily report of the inspector at the plant. Any discrepancy calls for an explanation. The tonnage of mix used is then divided by the total yardage reported by the street inspector on his daily report. The result must at least be equal to a previously determined weight per square yard. A discrepancy in this results in a "riot call" for contractor, inspectors and engineer-in-charge and just must be explained or rectified. The recorded temperatures of the asphaltic cement are rapidly considered for any evidence of overheating and the laboratory reports checked over as to grading of mix and amount and quality of asphaltic cement. These things can all be done by the secretary if the City Engineer or the Deputy Engineer are busy and only the variations noted. The remainder of the daily reports are read very carefully and any job that seems to need personal attention is visited during the afternoon.

The Report Forms.—All of the forms used for the above reports are uniform in size and as simple and convenient as possible. This uniformity of size is applied to specifications, extra work orders and extra work reports, thus making it possible for the inspector to keep all his data and reports between the covers of a single binder. All forms are made 3¾ in. x 6¾ in. in size—a real pocket size—and are punched for use in ring binders. Field reports are printed on pale blue and laboratory reports on a light orange paper. When the job is complete all daily reports, field notes, written orders, extra work reports, construction records and estimates are bound together in an inexpensive binder and filed away to form the office history of the job. It is surprising how many times these "histories" are needed for reference.

Attention is called to the fact that the system above described is not academic but rather is eminently practical and that it has stood the test of three years' exacting use without any serious change in the system or in the form. It is not to be understood that this system will supply ability that may be lacking in inspectors. No report can possibly tell how well the requirements of the specifications as to handling material or as to raking are carried out. The system will, however, from its very nature tend to increase the inspector's interest in and application to his job. It is sometimes objected that such a system requires too much time. This objection may be met with a flat denial. Finally it must be noted that the ultimate success of the system depends upon the engineer himself. If the reports are dismissed with a careless, cursory glance at least a third of the value of the system is absolutely wasted.

Kentucky Does Away with Convict Labor on Roads.—The 1922 General Assembly of the state of Kentucky has passed a law putting an end to use of convicts on road work. Under the act no convict may be employed outside the walls of the penitentiary or reformatory except for the purpose of quarrying or mining rock or other material used by the state in the construction of roads or bridges, and upon the capitol grounds, and then only when such mine or quarry is enclosed by walls or stockades. Permission is also given to the State Board of Charities and Correction to employ convicts on farms owned or leased by the state for the production of food for the inmates of the penitentiary or reformatory and they may also use convicts on public property of the state located at Frankfort.

Relation of Motor Trucks to Highway Construction and Maintenance

Abstract of a Paper Presented at the 19th Annual Convention of the American Roads Builders' Association

By J. G. McKAY,

[illegible]

The true purpose of an improved highway is a high degree of transportation service at the least possible cost to the public and road user. Clearly a traffic census is not a panacea, but I insist that without a knowledge of the actual traffic, speed, type and weight of a given area we are working in the dark. The actual traffic in terms of volume, density, speed and unit weights, must be correlated with laboratory and experimental impact tests as a guide to rational design. Independently each type of research is valuable, but the true worth of both cannot be realized until combined—in other words, interpreting the results of laboratory experiment in terms of vehicles on the highway.

Careful Analysis of Chief Traffic Element Necessary.—Our state and national investment in highway systems is constantly increasing. The investment in motor vehicles and the automotive industry is constantly growing steadily. A careful analysis must be made of the chief traffic elements responsible for increased construction and maintenance costs before the enactment of legislation which may, while protecting the highway, prove injurious to the growth of a highway transport service, and detrimental to the automotive industry.

We must be certain of our facts before we limit the traffic which may pass over any given highway. The limitation of wheel and gross loads must be based on definite information. The rapid destruction or ruin of gravel or macadam, and even concrete construction under heavy traffic does not necessarily mean that the construction of more durable pavement types is essential. It is conceivable that the heavy freighting vehicle is not an economic unit load, and that ultimately a smaller unit will become the maximum.

In making comparisons of the economies of the different methods of freight movement we are prone to make comparisons on the basis of operating costs alone. The true haulage cost must be based not only upon the cost of operation of the vehicle, but also a portion of the cost of building and maintaining a highway for the movement of vehicles, and must be included as a cost charge. Naturally this cost increases rapidly as the unit loads increase. Saving in transport costs may occur when heavy vehicles operate, reducing the freight costs by a few cents per ton mile. On the other hand a decided economic and social loss arises when new roads must be built, or maintenance costs are excessive, due to the utilization of the highway by heavy vehicles. The savings in operating costs of a few cents per ton mile are more than offset by the heavy construction and maintenance charge. It is not alone a question of cost, but the road is out of service which is even more serious.

Tire Width and Weight Limits.—It may be that an increase of the tire width per capacity of trucks to carry the freight load without destruction of the pavement is the solution. It is possible that the tire equipment should be capable of carrying the entire load, as suggested by Mr. Otto Armleder, manufacturer of Armleder trucks. This would solve the problem of overloading on the rear axle, but would not reach the problem of the total unit weight on the pavement, or overloading on the front axle. A study of the comparative economies of 3, 5 and 7 ton trucks with regard to highway construction and maintenance, vehicle operation costs, and service time, would settle this controversial point and determine the maximum economical load unit.

Today we see a strong tendency in the direction of restrictive legislation limiting the total loads which may pass over our highways and bridges. The classification of a highway system which limits the gross weight to 12½ tons on a very small percentage of the roads of a state, and to 7½ tons on the balance of the state system, definitely limits the manufacturer of trucks to a limited area for the sale of heavy vehicles. It is to his own best interests to co-operate in the solving of his difficult problem in order that his market may not be restricted beyond reasonable limits. The establishment of weight limits per inch of tire width must be based on conclusive evidence and research.

The manufacturer of trucks cannot afford to design and market vehicles which unduly increase the cost of construction and maintenance of our highways. The highway engineer cannot afford to build roads that will cripple or limit unduly the hauling capacity of truck. There is a joint enterprise, a movement of the maximum traffic at a minimum cost, and upon its successful solution rests the welfare of both the public and the vehicle manufacturer.

Truck Transportation and Existing Transport Systems.—It is an open question whether or not the ultimate sphere of motor truck operation is to be competitive with or supplementary to our existing transport system. The consideration of this problem carries with it far reaching consequences, beyond the mere comparison of the cost of movement of freight by one or the other type of carrier. The movement of freight is by nature monopolistic, and does not permit of true competition. Either one or the other type of transport will occupy the field. The junking of our railroad investment would involve the destruction of property rights representing approximately one-twenty-fifth of our national wealth.

We must consider the relative difference in the investment, comparing a large railroad system, with strict governmental regulation of rates and service, with fleets of motor vehicles in which the investment of the owner is small, with an absence of rate regulation or guarantee of service. The railroad investment is permanent and cannot move to an alternative field, it must operate or become a loss. The commercial vehicle operator, however, may move to alternative fields when profits fail. This naturally would endanger the guarantee of freight service which is more fundamental a question than cost.

It is difficult to conceive of the movement of heavy freight of low value by truck transport. The cost of moving such products as coal and iron, practically limits the commercial truck field to high value and low bulk goods. Can the railroads operate profitably moving the low value and large bulk commodity goods on the short haul, while the profitable business is absorbed by the motor vehicles? Any comparison of the two types of transport with a view of selection of the more economical type involves a comparison of costs. In such an analysis we must not forget that the cost of construction and maintenance of the road bed in both cases, is a part of the charge which must be made against the freight moved. A proper share of construction costs and maintenance costs of the highway must be paid by the truck operator, before a real comparison of rail and truck rates can be made.

A clear analysis of all the factors involved must be made before we can determine whether the field truck operation as a carrier is to be competitive or supplementary to existing transport systems.

Unprejudiced research is fundamental in the attempt to solve these many difficult highway problems. Supply definite information to the highway engineer with the assurance that the type and weight of traffic will not change over night, and he will build safe and permanent roads able to carry the traffic at a cost not exceeding the service value of the highway to the community. The vehicle manufacturer in all fairness is entitled to know the facts upon which he must design and build trucks which will meet the requirements of a constantly increasing highway legislation.

In approaching an analysis of some of the factors involved in highway construction and maintenance, and motor vehicle movement, a clear picture of the traffic passing over a given highway is essential to a thorough understanding of the type of construction necessary for traffic of a given type, giving at the same time a definite idea of the regularity of motor vehicle movement, density, weights and produce.

Limitations of the Traffic Census.—A traffic census may be defined as "a complete summation of traffic passing over the highways of a given area during a definite period of time."

Every traffic census has certain limitations and a traffic census based on the following plan has the following limitations:

A certain portion of the traffic over newly completed roads consists of "attracted" traffic from other routes and does not represent the true traffic which will ultimately pass over the particular highway observed. Allowance must be made for a redistribution of traffic when detailed highways of the complete system are constructed.

We cannot expect that a summation of vehicular movement will accurately portray future traffic. To obtain a picture of future traffic the census must be taken at given intervals over a period of years to determine the percentage increase of each vehicle type. The potential traffic of a given area to supplement the actual traffic census may be obtained by a survey of the agricultural and industrial growth of the community.

Only in a general way will the census data answer the question of the influence of various types of traffic on the highway without maintenance studies of the same road correlated with impact studies. To be able to interpret correctly the weight and volume data, accurate maintenance cost studies are essential. It is advisable in the selection of traffic census stations to place them on highways on which maintenance costs of the various types of pavement are kept.

The tonnage volume and weight per capacity of various vehicles will be of more value when combined with impact studies showing the effect on different types of pavements by impact tests. Being given the result of impact studies on the several road types, produced by the different vehicles, as shown by the census, the construction engineer can be assured of the type of highway he must build to carry the traffic. This will prevent over or under construction with the economic wastage occurring in either case.

In the past, traffic censuses have been taken by state highway departments largely for the purpose of determining the number of vehicles, passengers and types to indicate numerical movement. Generally such survey occurred during density of movement and for short periods of time. In a few cases the period of the survey was longer, while in one case actual weights were recorded.

The Main Purposes of a Traffic Census.—In the belief that the expense of taking a traffic census should produce more than surface results, and that the importance of the problems involved call for definite information, the following outline of traffic census is evolved.

The main purposes of a traffic census may be summarized as follows:

An aid in determining the economic value of a highway. Three principal factors enter into the valuation of a highway improvement. The increase in land values, highway service value in terms of passenger and freight ton miles, and the general value to a community. The only method of obtaining passenger and freight ton miles is by means of a traffic census for a definite period translated into yearly traffic.

Classification of vehicular traffic. A classification of traffic of the several types is useful in formulating traffic regulations, and to some extent in determining the percentage source of revenue from highway users in accordance with their actual use of the highway.

To determine gross truck weights and overloading per truck capacity. Weight and speed are guides to design, pavement selection, limitations of grade and alignment. The facts as to overloading per capacity can only be determined by a knowledge of front and rear axle distribution of weight in terms of loads per inch of tire width. It is not merely a problem of loads beyond a given maximum, but the real difficulty lies in overlooking beyond truck capacity.

Distribution of construction and maintenance funds. To distribute maintenance and construction funds in a fair proportion to traffic, we must know the volume and type of traffic on the different highways. The greater the volume of traffic, logically the greater the per cent of construction and maintenance funds allocated.

To determine traffic density and truck body widths. The peak of traffic hourly, daily and during the season is essential. Peak density and speed influence width of pavement and determines the maximum width necessary to carry the peak load. A direct ratio exists between vehicle body widths and pavement width. Pavement width increases with the increased speed movement of the vehicle, particularly when the load is heavy.

Seasonal and yearly traffic volume and density enable a prediction in a general way of future traffic.

To determine the vehicular movement of freight. Information as to regular and irregular trucking lines throws light on the proportion of regular freight movement. This is particularly valuable in the industrial states of the east and northeast. The average length of haul of commercial freighting indicates the field of competition of the truck and railroad, whether the short or long haul. The type, volume and value of commodities moved indicate the commodity competition and the per cent of high value and small bulk freight moved as compared with low value and large bulk freight. The average delivery time indicates the rapidity of movement of commercial freight service.

Information relative to truck operating costs and freight rates does not properly lie in the field of a traffic census, but must be made through independent studies.

Average speed of vehicles. These data must necessarily be obtained at the same time the census is recorded to check each vehicle observed in the speed test with the data obtained at the census station. The recording of the license number in each case permits the determination of capacity and weight. This information is useful in the formulation of speed regulations and their enforcement.

Bases of the formulation of traffic regulations and their enforcement. The information as to weight, overloading, tire condition, body widths and speed not only afford a reasonable basis of traffic regulation, but is the data upon which enforcement depends.

With those purposes in mind a comprehensive study of highway traffic was conducted in the State of Connecticut during August and October of 1921 by the Connecticut Highway Department in co-operation with the Bureau of Public Roads. This survey consisted of two traffic censuses conducted on two of the principal highways of Connecticut according to a plan I had outlined as the basis of a model traffic census, and was put into operation by Highway Commissioner Bennett of the State of Connecticut. Each survey covered a period of two weeks, and included two night surveys to determine the per cent of night movement. Scales were installed by the Connecticut Highway Department on the road side by means of which the actual weights of trucks were obtained.

Interests of Engineer and Motor Vehicle Practically the Same.—The production of highways and of vehicles which utilize our highways represent two industries in which the yearly investment exceeds by far any other two industries in the United States. The past few years have witnessed a tremendous growth of new highway construction and the volume and types of vehicles using our roads. The interests of the highway engineer and the producer of motor vehicles are largely the same. The one to construct and maintain highways which will carry a maximum of traffic of economical weight units at a minimum cost. The automotive manufacturer to produce vehicles which will move the traffic at a minimum cost and with the least damage to the highway. We cannot afford the waste of building roads to carry all types of traffic and unlimited loads, nor can we fit the vehicle to all types of highways. It is a combination of both, the building of suitable and satisfactory roads, and motor vehicles of the proper construction and weight. This is a joint industry of the road maker and the road user with a common object, the production of transportation at a minimum cost.

Naturally in any industry whose growth has been as rapid as the development of our highway system, abuses arise. Difficult problems develop upon whose successful solution rests the continued support of public approval. We have at present in the highway industry, many unsolved problems of highway economics and engineering which require immediate consideration. Intricate problems of finance, transportation, valuation, construction and maintenance, are a constant challenge to research in the field of high economics. This is a major field of operation and calls for the mutual co-operation of all people interested in seeing the creation of permanent and continually usable roads at a minimum of expense.

The Two-Fold Problem of Road Construction.—One of the most serious difficulties confronting the highway engineer today is the construction of roads which will remain in existence long enough to justify the investment, and at the same time withstand the hammering of the steadily increasing volume of weight to which the pavement and subgrade are subjected. This presents a two-fold problem. First the problem of excessive loads above a given maximum weight which results in the premature destruction of the highway. In 1921 only 1 per cent of the motor trucks manufactured were over 5 tons capacity. The California Highway Commission in a recent statement says: "As the ratio of use must be in close proportion to the ratio of production, it follows that only about 3 per cent of the vehicles using the California state highways are the so-called heavy duty type. Highway construction, like any other governmental activity, is based on public necessity and this necessity should be met reasonably when highways are built, adequate to sustain 90 per cent of the traffic. This percentage would include all motor vehicles, including the 2-ton capacity. Assuming $30,000 per mile as adequate to sustain 90 per cent of the vehicular traffic of the state and $50,000 per mile to construct a highway which will sustain the weight required by 10 per cent of heavy duty trucks, should the general taxpayer be required to invest an additional 66 per cent in road construction for the primary benefit of this particular call of heavy vehicles?"

We must fully recognize the necessity of automotive transportation, and the need for construction which will carry modern traffic, but first we must determine the economic load units, and second eliminate overloading. The weight of single units and speed are the two essential points of difficulty. The greater the speed of heavy loads the more damage to the highway. The ratio of damage to the road with an increase in speed is altogether out of proportion to the economies gained by faster movement.

The fact that pneumatic tires are found on the smaller capacity vehicles should seem to eliminate the use of the pneumatic tire as a solution. Reduction of speed, elimination of overloads, and restriction of gross tonnage and an increase in depth and width of solid tire equipment will reduce highway damage.

Load Classification of Roads.—The majority of heavy movement occurs on our trunk highways usually between industrial centers. There is, however, some movement of heavy loads on our secondary highways and generally the result is ultimately the destruction of the highways. Under adverse weather conditions, a single trip of a heavy load over roads built to carry light traffic results in its destruction. An example of what may occur was shown during the "Ship-by-truck" week a little over a year ago when an attempt was made all over the country to relieve the railroad freight congestion. The destruction of highways unable to maintain heavy traffic more than offset by many millions of dollars the economies which resulted by relieving the railroads of their freight congestion.

It is not contemplated that we will ever construct our secondary highways to carry the maximum loads imposed on our primary roads. To prevent the destruction of our secondary systems by heavy trucking vehicles and loads, a classification of highways is necessary limiting the maximum weight of vehicles moving over each road classification. The Wisconsin Highway Commission recently put into operation a classification of highways with the object of regulating track weights on its trunk highways and secondary roads. Class A roads limit the loads to 12 tons, while class B roads limit the load to 7½ tons. The majority of Wisconsin highways, primary and secondary at the present time, fall under class B. Class A roads consist of the more durable construction types, while class B consists of the less durable types. Strict supervision of the weights of vehicles using the highway, and severe penalties for violation of such a classification are essential in order to compel obedience to the law regulating the maximum and capacity weights which may move over each class of highways.

In Maryland all loads in excess of 10 tons, vehicle and load, are forced to unload excess weight at once, leaving it on the highway. Ohio orders overloaded trucks off the road. Gross weight limits in the various states range from 6¾ tons maximum in Vermont to 15 tons maximum in California, Michigan and New Jersey. About one-half of the states specify a maximum load per inch of tire width ranging from 500 lbs. per inch in Idaho, Oregon and Texas, to 800 lbs. per inch in Connecticut, Illinois, Iowa, New Jersey, New York, Pennsylvania, Washington, Wisconsin, Minnesota, Massachusetts, Maine and Kentucky.

Road Factors that Must Be Considered in Load Regulations. Regulations as to gross weight and overloading must take into consideration two road factors. First, the difference in road types, permitting heavier gross loads, and loads per inch of tire width on the more durable types, limiting both gross load and weight of wheel load on less durable types. Second, in those states in which there are considerable climatic variations, restrictions should be imposed during the early spring, when the pavement is more easily destroyed than later when the frost has disappeared and the road is not susceptible to injury.

The second phase is the problem of overloading per truck capacity. My analysis deals primarily with this problem, which is by far the most serious. The limitation of loads to a maximum of 25,000 lb. does not prevent the overloading of trucks whose rated capacity falls below the maximum load provision.

In the Connecticut Censuses, at each of the stations, the width of tire was taken by measuring the impression made by the wheel load, front and rear, after passing over strips of impression paper. The front and rear axle weight was procured in order to determine the total load, and distribution of load, on the front and rear axle. These figures enabled me to determine the wheel load per inch of tire width for each truck, make and capacity. The make and capacity of the truck were necessary in order to compare the manufacturer's total weights, and percentage distribution of weights, front and rear axle, with the actual weights recorded, to arrive at the overloads per capacity.

Limitations of Analysis of Overloading.—Any analysis of overloading has certain limitations in the present state of highway research. (1) The lack of maintenance cost studies of the highways on which the surveys occurred, does not permit of establishing accurately the direct relationship which exists between overloading per capacity and high maintenance costs; (2) the effect of overloading on the pavement and subgrade can best be shown when correlated with impact studies of the several pavement types; (3) criticism of the overload data on the basis of the standard used in determining overloads. The weight standard used to determine overloads for each make and capacity consists of a summation of the manufacturers' 1920 weights for the chassis, body, and rated capacity, giving the total weight when loaded to capacity. The percentage distribution of weight recommended by the manufacturers of trucks for front and rear axle load is used as a standard for determining overloads on the front and rear axle. In order to be conservative 5 per cent of the total chassis, body and capacity weight was added to the manufacturers' given weight and used as the standard for computing total overloads per capacity. One-half of this 5 per cent was added to the front and rear axle standard weights in arriving at overloads for the front and rear axle. For example, if the chassis weighs 7,000 lb., the body 1,600 lb., capacity 7,000 lb., a total of 15.600 lb., 5½ of 15,600 lb., or 780 lb. was added, making a standard for total overloads for this capacity of 16,380 lb. In addition 390 lb. was added to the front and rear axle weight, and the totals used as a standard for judging the front and rear axle overload. This basis seemed fair, and even an allowance of 10 per cent would have made little material difference in the result.

Much Lower Bids Made for Construction of Hard Roads.—Early bids for the construction of federal aid roads indicate that prices during the coming season will be materially lower than last season, according to reports received by the Bureau of Public Roads of the United States Department of Agriculture. While bids have not been received on any large volume of work, there is, however, enough to indicate a lower level of prices. Grading has been bid at 20, 23½, and 30 cts. a cubic yard in Missouri, Arkansas, and Minnesota, respectively, as compared with an average of 35 cts. for the section in which these states are located in 1921. Prices of reinforcing steel in place range around 6 cts. as compared with the 1921 price of 8 or 9 cts., and bridge steel at 4¾ cts., against 7 to 8 cts. A few bids, for the best grade of concrete, of about $17 a cubic yard have been received in sections where the 1921 price was about $25 a cubic yard. Prices bid for the construction of concrete roads per square yard are as follows: Ohio $1.52, Colorado $2.27, and Georgia $1.38, as compared with an average for the whole country during the period 1916-1920 of $2.57 a square yard.

Carnegie Corporation to Found Economic Institute.—The Carnegie Corporation of New York announced the establishment of an Institute of Economics which will undertake to supply to private individuals, business concerns and to Government officials reliable information on all economic questions. To finance the new institution the Carnegie Corporation of New York has set aside $1,600,000. This is expected to pay the costs of the undertaking for 10 years.

Selection of Mineral Aggregates for Concrete Roads

Test Methods and Results and Principles Which Should Govern Selection and Use of Aggregate Described in Paper Presented Jan 19, Before the American Road Builders Association Good Roads Congress

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The aggregate comprises about 80 to 85 per cent of the total volume of materials used in concrete; consequently this type of material is of considerable interest to all who are engaged in concrete road construction. On account of the great weight and expense of shipping long distance, it is essential that aggregates near at hand be used if they are at all suitable. Due to the almost endless variety of materials available, the preparation of a proper specification and methods of test are most complicated. The requirements to be met must be dictated to a certain degree by local conditions and economic considerations. Many researches both in the field and in the laboratory have been carried out during the past few months or are now under way which throw much light on the proper requirements for aggregates for concrete roads.

General Requirements.—Aggregate for concrete road construction must be clean, structurally sound and inert in the presence of cement and water. These properties imply also a certain quality which we may term weather-resistance. A wide variety in size and grading may be used with satisfactory results.

A digest of the specifications for concrete roads of the State Highway Departments shows that about 80 per cent of the states have some requirements for the abrasive resistance of coarse aggregates. Generally the minimum size of coarse aggregate is placed at ¼ in. and the maximum size at 1½ to 3 in. The requirements for fine aggregates are somewhat less specific; the grading is generally specified as finer than ¼ in. In some instances certain requirements for smaller sieves are included. Mortar strength tests are generally required.

Aggregate Tests.—Tests of concrete aggregates are made for two distinct purposes:

(1) To establish underlying principles, and

(2) To determine whether a given sample conforms to certain predetermined standards.

The two purposes in testing mark the distinction between research and inspection.

Tests of aggregates have been undergoing marked changes during the past few years. The earliest tests of coarse aggregate were adapted directly from those made on rocks for macadam roads. Experience has shown that the tests for hardness, toughness and cementation value are of little use in judging of the quality of an aggregate for concrete.

It is unfortunate that standard tests for concrete aggregates have not thus far been developed and generally accepted. The American Society for Testing Materials, the Bureau of Public Roads and other organizations have done much toward standardization but much remains to be done. In view of the absence of generally accepted standard tests, I can probably do no better than to describe the tests used in the Structural Materials Research Laboratory, Lewis Institute, Chicago.

Tests at Lewis Institute.—Several thousand samples of both fine and coarse aggregates from all sections of the United States have been subjected to test during the past seven years. In many instances samples were sent in by engineers or contractors from concrete road jobs. Large numbers of samples were collected especially for research purposes. The methods of the American Society for Testing materials have been followed where such methods have been recommended. It should be noted, however, that in many instances the A. S. T. M. methods have only recently been published as tentative standards and there has not been sufficient time for them to come into general use.

Fine aggregates are subjected to the following tests:

Sieve Analysis—Per cent coarser than Sieves Nos. 100, 50, 30, 16, 8 and 4. (Follow Tentative Method A. S. T. M., 1921.)

Silt—Loss of weight of 500 gram sample, dried, by washing in shallow pan and rejecting wash water. (Follow A. S. T. M. Standard Method for Test for Quantity of Clay and Silt in Sand.)

Unit Weight—Puddle into 1/10 cu. ft. cylindrical measure in 3 layers. (Follow A. S. T. M. Standard Method of Test for Unit Weight of Aggregate for Concrete.)

Impurities in Sand—Digest sample in 3% solution of sodium hydroxide, observe color after 24 hr. (Follow A. S. T. M. Tentative Method of Test for Organic Impurities in Sands for Concrete.)

Mortar Strength—Compression tests of 2 by 4-in. mortar cylinders at ages of 7 and 28 days, using 1-3 mix by weight and by volume. Make parallel tests on 1-3 standard sand mortar. (Follow A. S. T. M. Tentative Test for Compressive Strength of Portland Cement Mortars.)

Coarse aggregates are subjected to the following tests, so far as the quantity of material permits:

Sieve Analysis—Per cent coarser than U. S. Standard Sieves Nos. 8, 4, ⅜, ¾ in. and 1½ in. (Follow A. S. T. M. Tentative Standard.)

Unit Weight—Puddle with 1/5 or ½ cu. ft. cylindrical measure in 3 layers. (Follow A. S. T. M. Method of Test for Unit Weight of Aggregate for Concrete.)

Abrasion—Deval abrasion tests. Follow A. S. T. M. Standard method if aggregate is satisfactorily graded, otherwise use test as modified by Rea, Mattimore or Abrams.

Concrete Strength—Compression tests of 6 by 12-in. concrete cylinders at ages of 7 and 28 days, using 1-4 mix with local concrete sand, graded up to No. 4 sieve. Make 5 cylinders on different days from separate batches, mixed by hand. (Follow Tentative Methods of Making Compression Tests of Concrete of the A. S. T. M.)

Wear of Concrete—Use 8 by 8 by 5-in. blocks in Talbot-Jones rattler, 1-4 mix, relative consistency 1.10, test at 28 days. Mold specimens in metal forms and finish by hand. Make 5 specimens.

Sieve Analysis of Aggregates.—The sieve analysis of aggregates is important, but it must be properly interpreted. Good concrete can be produced of aggregate of almost any size and grading (if of good structural quality) providing these characteristics are taken into account in designing the mix to be used. The division of aggregate into fine and coarse is largely arbitrary, but should be preserved as a means of securing uniformity in the grading of aggregate in successive batches of concrete.

The practice of mixing fine and coarse aggregates in fixed proportions without regard to size and grading should be discouraged. A number of researches have been published during the past 2 or 3 years which indicate methods of dealing with this problem; all such methods are based on the sieve analysis of the aggregate. Elaboration of these methods is not within the scope of this paper.

The following from the tentative specifications of the Joint Committee on Concrete and Reinforced Concrete seems to place the grading of fine aggregate on a proper basis:

Fine aggregates shall range in size from fine to coarse, preferably within the following limits:

Passing through No. 4 sieve—not less than 95 per cent.
Passing through No. 50 sieve—not more than 30 per cent.

It will be noted that the grading is not mandatory; if fine aggregates of other gradings are used the proportions of cement, coarse aggregate and water should be such as to give concrete of the desired strength.

The writer wishes to urge the general adoption of the sieves named above for concrete aggregate. They now have the backing of the Bureau of Standards, the A. S. T. M., the Joint Committee on Concrete and Reinforced Concrete, as well as other influential organizations. These sieves are on a scientifically sound basis in that the width of the clear openings of each sieve is exactly double the width of the next smaller one and the ratio of clear opening to wire diameter in the different sieves follows a definite law.

In this connection it may be well to say a few words on the relation between the sieve sizes mentioned above and the sizes of material produced by commercial screens using perforated plates. A little consideration will show, and the investigations of the Bureau of Public Roads have proven that the size of aggregate produced by a commercial screen is determined by one or more of the following factors, which have no relation whatever to the size of the opening:

(1) Thickness of plate.
(2) Wear of plate.
(3) Diameter of screen.
(4) Length of screen.
(5) Inclination of screen.
(6) Rate of rotation.
(7) Rate of feed.
(8) Wet or dry screening.

In other words, a sieve analysis under standardized conditions is necessary to give the actual sizes of material produced, although it may have been screened at the plant.

There is a marked tendency now to go to larger sizes of coarse aggregate in concrete roads; a number of specifications now admit aggregate up to 3 in.; this tendency should be encouraged.

Silt in Sand.—In usual concrete work a small percentage of silt in sand is not objectionable, so long as it does not contain organic impurities and providing an excess of mixing water is not used. However, in the wearing surface of concrete roads, silt is especially objectionable, since it is likely to be drawn to the surface in finishing, hence producing a weak and friable concrete where concrete of the highest quality is needed. The quantity of silt should not be greater than 3 per cent by weight. If sands of higher silt content must be used, the following precautions should be taken:

(1) Reduce the quantity of sand to a minimum.
(2) Reduce the quantity of mixing water to a minimum.
(3) Work surface as little as possible in producing a finish.

The quality of concrete will in any case be improved by following (1) and (2) above.

Unit Weight of Aggregate.—The unit weight of aggregate is in general of little value except as a means of arriving at the quantities of materials necessary for concrete of a given mixture. In the case of slags and aggregates of unusual types, the unit weight may be of value in furnishing some notion of the character of the material. The old notion that heavy aggregates are better than light ones has little basis in fact.

Organic Impurities in Sands.—Organic impurities in sand is objectionable, due to the fact that such materials either greatly retard or entirely prevent the setting and hardening of cement. Such impurities generally come from carelessness in stripping the overburden from sand and gravel pits.

The colorimetric test with sodium hydroxide which originated in this laboratory is becoming generally accepted as a satisfactory criterion for this purpose.

Mortar Strength of Fine Aggregate.—The compression test is much to be preferred over the briquet test for mortars. The comparison with 1:3 standard sand mortar at 7 and 28 days gives valuable information, providing the test is properly interpreted. If three sands give mortar strengths of 70 per cent, 100 per cent and 130 per cent of standard sand, it does not follow that concrete made from these sands will show the same strength-ratios. In fact, they will show about 90, 100 and 110 per cent. The reason for this lies in the fact that in concrete the sand is only, say, one-third the total aggregate, hence difference in strength of concrete, due to variations in the sands, may be expected to be only about one-third those found in sand mortars. Sands which fall below standard in mortar tests may be used with good results, providing the mixtures are modified accordingly.

Abrasion Test of Aggregates.—While the abrasive resistance of coarse aggregates, as determined in the Deval machine, is generally specified, it should be stated that many engineers are beginning to question its value in selecting materials for concrete roads. In general the standard test for macadam rocks cannot be made through inability to secure pieces large enough; the test is meaningless when applied to pebbles. These conditions have led to the use of modifications of the old standard test. Three modifications have been extensively studied in this laboratory.

The abrasion tests may be described briefly below. All methods use the Standard Deval machine, run at 30 r.p.m. The per cent of wear is in all cases based on material rejected by the 1/16 in. mesh sieve after test.

Method.	Characteristics.
American Society for Testing Materials	50 pieces weighing 5,000 gm., run for 10,000 revolutions.
Mattimore	Same as A. S. T. M., except that test cylinders provided with 1/16-in. slots which rejects fine materials as produced.
Rea (Modified)	5,000-gm. sample (or equivalent volume in case of materials of unusual weight) 2,500 gm. ⅜ to ¾, 2,500 gm. ¾ to 1½ in.; 6 cast-iron balls, 1⅞ in. diam., 1,000

	revolutions. [illegible] original method required the use of [illegible] 1 and 2-in. circular screens.
Abrams	4,000-gm sample (or equivalent volume); 2,000 gm [illegible]; 2,000 gm ¼ to 1½ in.; 10 cast-iron balls [illegible] in. diam., 2,000 revolutions

The last method has the merit that it can be made in 1 hour, whereas the other tests require over 5 hours. This is our principal justification for proposing this method. The sieve sizes conform to the U. S. Standard and the percentages of material of different sizes are such they can be selected from nearly any sample of crushed material which is presented for test.

The relative wear produced by the various tests may be shown from the following values which were secured from parallel tests in a recent investigation:

	Relative Wear				
	Limestone	Trap	Granite.	Sandstone.	Slag
Method	(12)	(4)	(2)	(4)	(3)
A. S. T. M.	100	100	100	100	100
Rea (Modified)	505	[illegible]	1160	686	167
Mattimore	315	[illegible]	[illegible]	208	175
Abrams	250	204	[illegible]	513	74

The per cent of wear of each material by the A. S. T. M. Method was taken as 100. The numerous inconsistencies in the table are probably due as much as anything to the variations in the performance of the A. S. T. M. method when applied to materials of widely different types. It seems apparent that the A. S. T. M. test should be abandoned for this purpose.

There has been a marked tendency to lower the limiting per cent wear for crushed rocks to be used in concrete roads; this is partially due to recent changes in the type of traffic and to a growing realization that the wearing resistance of the aggregate has only a remote bearing on the wearing resistance of the concrete. This subject is referred to below under wear tests of concrete.

Concrete Strength.—Testing aggregate by means of compression tests of concrete is not necessary unless the aggregates present some unusual characteristics; and in general is not necessary in routine inspection work. Such tests furnish the best information for research purposes and should be encouraged. The methods recently published in tentative form by the A. S. T. M. should be followed in making such tests.

Wear Tests of Concrete.—Wear tests of concrete by means of the Talbot-Jones rattler furnish an excellent method for research purposes, but are not practical as a routine method of inspection. A ring of 10 separately molded blocks 8 in. square and 5 in. thick is fastened to the rotating head of the machine, where the finished surfaces are subjected to the tumbling action of a 200-lb. charge of cast-iron balls for 1,800 revolutions, requiring about 1 hour. The results of several thousand tests of this kind will be found in the published reports of the Lewis Structural Materials Research Laboratory. A recent series of tests which has not been reported in detail shows that the type and quality of the aggregate produced less effect on the wearing resistance of concrete than is usually supposed; and that rather wide changes in grading of coarse aggregate produced relatively little difference in wear of the concrete.

It should be stated that there is a well-defined relation between wear and strength; the factors which produce high strength, produce low wear.

It is believed that further study of data now on hand in tests carried out by the writer will bring out valuable information on the influence of the quality of the aggregate as revealed by the various abrasion tests and the strength and wearing resistance of the resulting concrete.

Need for Further Research and Standardization.—The foregoing remarks make apparent the great need for further research and standardization of methods of dealing with concrete aggregates.

Field tests now under way by the Bureau of Public Roads and by the State Highway Departments of Illinois and Pennsylvania may be expected to give important results on the relative merits of different aggregates. The Bureau of Public Roads, a number of state highway departments, and other laboratories have carried out laboratory investigations of aggregates which have thrown light on the properties which must be required for good results.

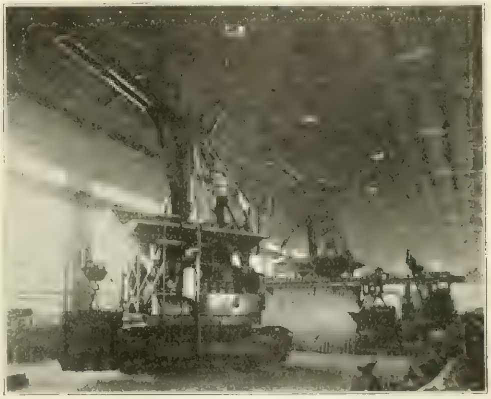
Conclusion.—No attempt has been made in this brief review to suggest a complete specification for aggregate for concrete roads; however, certain principles which should govern the selection and use of aggregates are given.

There is a marked tendency to disregard minor features in specifying concrete materials and to base final conclusions on the quality of concrete produced.

High grade aggregates are only one of the many requirements of good concrete; the best aggregates do not insure good concrete if the methods of proportioning, mixing, placing and curing are faulty.

Mixer Has Special Derrick Arrangement for Handling Batch Boxes

A new arrangement for handling batch boxes from car to mixer will be used by C. F. Lytle, Sioux City, Ia., on his contract for constructing 44 miles of concrete roads from Jacksonville, Fla. All materials for the contract will be handled by industrial railway. Two 28 cu. ft. (mixed material), Austin mixers will be used. These mixers have been equipped by the Austin Machinery Corp. with a special derrick arranged as shown in the illustration, by means of which the 45 cu. ft. batch boxes will be lifted direct from the car and dumped in the hopper on the mixer. This does away with the loading skip on the mixer and makes a saving in time in changing.



Mixer with Special Derrick Equipment.

Annual Meeting of National Highway Traffic Assiciation.—The National Highway Traffic Association will hold its annual meeting on May 12 at the Automobile Club of America, 247 W. 54th street, New York City. Reports on the following subjects will be presented by national committees: "Uniform Highway Signs," Chairman Elmer Thompson, secretary, Automobile Club of America; "Traffic Capacity and Widths of Highways Outside of Municipalities," Chairman Herschel C. Smith, assistant professor of highway engineering and highway transport, University of Michigan; "Status of the Construction of Highway Curves and Recommended Practice to Increase Safety to Traffic," Chairman H. Eltinge Breed, consulting highway engineer, New York City; "Regulations Governing Speeds, Weights and Dimensions of Motor Trucks and Trailers," Chairman George H. Pride, president, Heavy Haulage Co. of New York City; "License Fees and Motor Vehicle Taxation," Chairman Henry G. Shirley, roads and sanitary engineer, Baltimore County Roads and Sewerage Department; "Highway Transport Franchises," Chairman F. W. Fenn, secretary, National Motor Truck Committee, National Automobile Chamber of Commerce; "Highway Transport Clearing Houses," Chairman Tom Snyder, secretary, National Association of Commercial Haulers, Indianapolis.

11,017 Miles of Federal-Aid Roads Completed.—Federal-aid roads completed since 1916 totaled 11,017 miles on March 31, an increase of 8,016 miles during the preceding 12 months, according to the Bureau of Public Roads. The general average cost per mile for the United States was $17,120.

The Salaries of Highway Engineers*

By D. Q. McCOMB

[illegible] Tennessee State Highway [illegible]

For a number of years the question of pay for engineers has been one of extreme importance. Although a distinct profession, the same as medicine, the law and others, the vast majority of engineers work on salary, the amount of which in practically all cases is determined by the employer, whereas in other professions the amount of reimbursement for professional services, in fees, is determined by the one rendering the service. A graduate engineer, with a college degree, has spent fully as much time and money in going to college, and his responsibilities after graduation are fully as great, if not greater, than those of men in other professions.

The engineer is the professional pioneer. It is he who first penetrates the wilderness of his own land or the jungles of the tropics, making reconnoissances, locating, constructing and operating railroads, opening mines, building highways, etc., not only for his own people but for all the peoples of the earth—witness the work now being done by American engineers in Haiti, or in the Philippine Islands, laying out and constructing systems of modern highways covering the entire country. The very nature of his duties make it practically impossible for him to become permanently established in any one locality. As soon as his work is completed in any particular locality he moves on to where other duties of the same nature await him. Even in highway work in the various states a resident engineer stays but five or six months in one place, and when his road project is finished he is transferred to a new project somewhere else. It is a well known fact that any man permanently located in one community, and living with his family in his own home, can live far more economically than if he and his family are located only temporarily in some place where by the very transitoriness of their stay they are compelled to board, either with a private family, wherever possible, or very frequently at some hotel in the vicinity.

Salaries of Government Engineers.—For years the Federal Government has been a large employer of technical men, not only engineers, but specialists in other lines as well. Up to two years ago its policy in respect to payment of salaries was niggardly in the extreme. Two years ago, due largely to high and increasing costs of living, the situation became indeed acute, and so many highly trained engineers and other specialists left the government service for more lucrative private service, that the government was compelled to take cognizance of the situation, and take steps to ameliorate the condition of its employes. In March, 1919, a joint congressional committee was appointed to investigate conditions and draft a reclassification bill, under which all Federal civil service employes would be uniformly classified, with uniform salary schedules for the respective classes. Another feature corrected, also, was the inconsistent policy of paying employes of the same grade, with the same amount of experience, and doing exactly the same kind of work and with the same degree of responsibility entailed, salaries varying from 60 to 80 per cent in the various departments and bureaus. After a most exhaustive investigation, requiring almost two years to complete and the report of which covers one thousand pages, this reclassification bill, known as the Lehlbach Bill (H. R. 8928), was formulated, introduced and passed in the House in December, 1921, and transmitted to the Senate. In the Senate it was referred to the Committee on Civil Service, reported favorably back, and unless all indications fail it will become a law during the present session of Congress.

In the section devoted to government engineers, the salaries are fixed as follows:

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Chief engineer	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Assistant chief engineer	[illegible]	[illegible]	[illegible]	[illegible]
Grade [illegible]	Division engineer	[illegible]	[illegible]	[illegible]	[illegible]
Grade [illegible]	Assistant division engineer	[illegible]	[illegible]	[illegible]	[illegible]
Grade [illegible]	Resident engineer	[illegible]	[illegible]	[illegible]	[illegible]
Grade [illegible]	Junior engineer	[illegible]	[illegible]	[illegible]	[illegible]

Salary Recommendations of A. A. E. Committee.—Among recomemndations submitted to the Joint Reclassification Congressional Committee was one by a committee of the American Association of Engineers, a national engineering organization of over 30,000 strong, assisted by corresponding members consisting of Mr. Thomas H. McDonald, Chief, U. S. Bureau of Public Roads, the Chief Engineers respectively of the State Highway Departments of Pennsylvania, California, Massachusetts, and Illinois, and others interested particularly in highway construction, in which salaries recommended were as follows:

Chief engineer, $8,000-$10,000.
Assistant chief engineer, $[illegible]-$[illegible].
Office engineer, $[illegible]-$[illegible].
Bridge engineer, $[illegible],000-$[illegible].
Testing engineer, $[illegible],000-$[illegible].
Division engineer, $[illegible]-$[illegible].
Assistant division engineer, $[illegible]-$[illegible].
Resident engineer, $2,[illegible]-$[illegible].
Junior engineer, $1,800-$2,[illegible].
Inspector, $2,400-$[illegible],000.
Instrument man, $1,800-$2,[illegible].
Rodmen, chainmen, $1,200-$1,[illegible].

In its recommendation this Committee of the American Association of Engineers stated:

"The basic purpose of the recommendation in the highway field is to secure a salary for the man who elects a career in a highway engineering that will reasonably assure him, under present conditions, an opportunity to support and educate his family in a modest way. As we reach those positions which demand a wider experience and special accomplishments which make the engineer of judgment and administrative ability, the salary to be paid should represent the value of the service rendered to the public and be commensurate with the responsibilities imposed."

Salaries of State Highway Engineers.—A report recently prepared by the United States Bureau of Public Roads shows in detail the salaries paid engineering employees in all the State Highway Departments in the Union during the year 1921.

SALARIES FOR STATE HIGHWAY ENGINEERING EMPLOYES, 1921

No. states.	Title.	Maximum salary.	Minimum salary.	Average salary.	See below (A)
40	Chief engineer	$[illegible]	$3,000	$5,795	21
37	Asst. chief engineer	[illegible]	2,400	3,820	27
30	Hdqrs. office engr. .	[illegible]	2,100	3,027	10
41	Bridge engineer	[illegible]	2,100	3,707	16
30	Testing engineer . .	[illegible]	2,100	2,970	14
44	Division engineer . .	[illegible]	2,400	3,404	20
22	Asst. division engineer	[illegible]	1,750	2,790	14
12.	Division office engr.	[illegible]	1,800	2,340	5
31	Resident engineer . . .	[illegible]	1,800	2,670	16
18	Junior engineer	[illegible]	1,080	1,931	9
44	Instrumentman	[illegible]	1,080	1,661	15
42	Inspector	[illegible]	1,200	1,813	14
40	Rodmen, chainmen . .	[illegible]	780	1,0[illegible]	28

Column (A) shows the number of states in which employees in each classification are paid equal or more than the average of all the states as shown.

In the 40 State Highway Departments employing a Chief Engineer 21 pay salaries higher than the average.

Highway engineering in the United States has now risen to a position of first importance in the engineering field. Hundreds and hundreds of millions of dollars are now being spent in the location, design, construction and maintenance of adequate and durable roads throughout the country. The responsibilities resting upon all connnected in any way with this work, and particularly with the expenditure of funds and the supervision of work in progress, are indeed tremendous, and demand the services of men of sterling integrity, training of the highest character, and broad experience, if these funds are spent with the greatest economy to produce results of greatest efficiency. The services of such men can be secured and held only by the payment of adequate salaries, commensurate with the degree of responsibility resting upon the individual engineer, and any state pursuing a stingy, parsimonious policy in this respect will assuredly fail to produce results of the highest class.

Road Types on Lincoln Highway.—On Feb. 1, 1922, the mileages of the various types of road construction on the Transcontinental Route of the Lincoln Highway, New York to San Francisco, were as follows:

	Miles
Concrete	[illegible]
Brick	[illegible]
Bituminous macadam	[illegible]
Macadam	[illegible]
Asphalt	[illegible]
Concrete block	[illegible]
Granite block	[illegible]
Graded gravel	[illegible]
Natural gravel	[illegible]
Graded earth	[illegible]
Natural earth	[illegible]
Sand	[illegible]

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*[illegible]

Motor Truck Transportation

Organization and Operating Methods for 1300 Trucks of Standard Oil Co., Described in Paper Presented at Convention of New Jersey Highway Association

By J. F. WINCHESTER.

Superintendent of Motor Vehicles, Standard Oil Co. of New Jersey

Fundamentally, the operation of motor vehicles for profit or business purposes is like any other business—it must be organized. To make a success of a business of this type, the party venturing into it should study the various angles of the particular line he intends to pursue and then carefully outline his course of action, with the full realization in mind that there is no line of business that presents as many possibilities for "leaks" as an unorganized motor bus or truck business.

Let us consider the factors that enter into motor transportation enterprises, none of which can be neglected to any great degree if the outfits are to be economically operated and maintained. I know of no better presentation of them than the outline recently presented in a paper before the S. A. E. by Mr. M. C. Horine.

The factors presented by Mr. Horine cover a wide range of consideration and necessitate a general knowledge of

Highway engineering,
Mechanical engineering,
Automobile engineering,
Electrical engineering,
Transportation,
Bookkeeping,
State laws, etc.

The Need for Specialists.—However, Mr. Horine neglected to include the human element side of the question in his table of economic factors, which I consider has an important bearing on the efficiency of any operation. So much general knowledge is known about an automobile by the general public, yet there are few specialists who understand the fundamentals of the various factors that careful selection and training is necessary if the organization is to be efficient.

The organizer of a department of any size should have a knowledge of man-power, and understand the psychological elements of organization in order that harmony and teamwork may prevail, without which discipline and the possibility of economical operation would be at a premium.

These specialists all co-ordinate the activities of the motor vehicle in an economical way with the rest of the business. The type and extent of the organization which one would adopt depends to a large degree on the number of vehicles to be operated and the extent of the territory which they cover.

Each type of industry, whether it be a contracting concern, silk, express or oil business, has surrounding it certain business conditions with which the supervisor of motor vehicles must be more or less familiar.

For instance, in road building it is not only necessary that a man have a general knowledge of the motor vehicle itself, but it is also necessary, if he is called upon to make an installation of any vehicle for road oil or binder distribution, that he have a general knowledge of the material to be applied by the vehicle and the various types of pumps that might be used for its application. His other general engineering knowledge would fit him to work up a design that would be suitable from a mechanical standpoint. The conditions surrounding an installation of this kind would be mounting, driving and gearing the pump so that it would be practical to operate, accessible, economical to maintain, and capable of giving the proper volume distribution for the various types of work encountered by the vehicle.

Standard Oil Co.'s Truck Department.—(Fig. 1.) I do not presume to outline to you the type of organization that might fit your varying conditions, but I will present for your consideration an organization chart which provides for the handling of approximately 1,200 to 1,300 vehicles which are operated over a widely scattered territory in the states of New Jersey, Maryland, District of Columbia, Virginia, West Virginia, North and South Carolina, and which vehicles are under centralized control.

This organization chart is the result of ten or twelve years' direct experience in motor transportation, and the vehicles under this plan are being operated in direct competition with other types of transportation, namely, horse drawn and steam. In at least 98 per cent of the cases each outfit is doing the work, at least within a slight margin, more economically than it could be done by any other form of hauling.

This chart indicates that the branch of the company in which these vehicles are being operated is a sales organization, and that the relation of the motor vehicle department to the balance of the organization.

The chart also indicates that the superintendent of vehicles has directly under his supervision men who handle the inspection and mechanical upkeep of the outfits, and that he is responsible for the installation of the various types of motor vehicles, and, while not directly responsible himself for the vehicle operators, he is in direct touch with them through education and the auto inspectors who visit periodically all of the outfits.

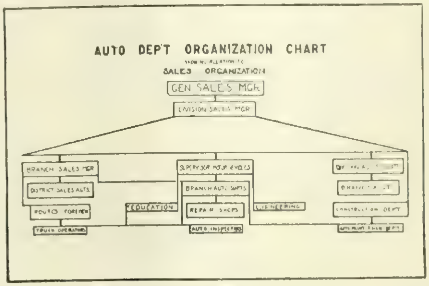


Fig. 1.—Relation of Motor Vehicle Department and Balance of Organization.

The output from the vehicles is directly up to the branch sales manager through the route foreman, and the gathering together of the reports turned in by the two departments is under the supervision of the accounting department.

The painting of the vehicles is done by the construction department, in most cases, for economic reasons.

The Shop Organization.—Fig. 2. shows the approximate plan on which all of our shops are operated. In forming a shop organization, one has to take into consideration the fact that in automobile work practically all branches of the mechanical arts are encountered. A man who superintends this work should be one who has fundamentally been educated to think along mechanical lines. I prefer one who has served an apprenticeship as a machinist or tool-maker, and has educated himself along engineering lines. He may be called upon to consider problems wherein the following lines of work may have to be considered:

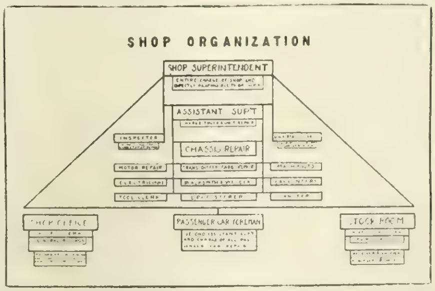


Fig. 2.—Plan on Which Motor Vehicle Shops Are Operated.

Designing,
Pattern making,
Foundry practice,
Machine shop practice,
Tool-making practice,
Blacksmith practice,
Electrical,
Painting,
Tinsmith,
Wheelwright,

Body building
Carpenter,
Upholstering
Stockkeeping,
Service problems, etc.

A man so equipped will be in a position which will tend to make him resourceful and capable of instituting many short cut methods, which will result in a large yearly saving. He should, along with his mechanical training, possess those qualities which fit him to instill in others a desire to perform their duties in a harmonious, careful and conscientious manner.

The outline as shown presents a practical working organization which is in operation and is producing economical results.

Considerations in Selecting Truck. When a vehicle is to be purchased, the type of work and the country into which it is to be installed are carefully studied from the various angles pertaining to an efficient installation.

In my particular line, a canvass is made of the approximate number of gallons or packages that will be delivered in the respective territory under consideration. We study, particularly, the adaptability of the road to carry it so that we may have installed the proper transmission and read axle ratios, tire make and sizes and take particular pains to install an outfit whose gross weight is suited for the road and bridge conditions into which it is going.

Care should be taken in studying an individual installation to make sure that it will compare from an economical standpoint with other types of transportation that are at one's command.

The matter is becoming a more complicated one yearly regarding an installation. Legal restrictions, high license fees, and general taxation necessitate a closer studying of this problem than ever before.

The question of standardization has to be studied, and while standardization can be argued for from a standpoint of making it much easier to handle the vehicles, yet, on the other hand, when a large fleet is considered, it is well not to limit the make of vehicles by make to any particular make, for the reason that you have left no direct method of comparison as between one make and another. We standardize the make in a district or at a station, and try to hold a station to not more than two makes, which simplifies the service and operating problem.

After having taken into consideration the various possibilities, and it has been found feasible to make an installation if goods are to be economically hauled, the largest load possible under existing conditions should be hauled, for the reason that all operating figures will show that the unit cost, such as ton-mile, etc., is materially higher where small units are used. Also, from the standpoint of general operating economy, the installation of a heavy unit is preferable to a small one, as a large unit simplifies the problem of control and handling for the reason that fewer units are required.

Control of Motor Vehicles. That the location of a machine may be determined at any time, accurate records are kept of the vehicle number and the station to which it is assigned. In between times and as vehicles are moved from one station to another they are taken care of by "Between Station Transfer Reports."

For the ready reference of those who are directly concerned in the location of vehicles a control board is run and all vehicles in the territory are spotted in their respective locations by numbers on this board. The make of vehicle is indicated by the shape of the cardboard on which the number is printed, which cardboard takes the form of the vehicle radiator. The type of service, such as gasoline or oil tanks, barrel or package truck, is indicated by the color of the tack head. By this control board, vehicles may be located at any time, whether they are in the shop or at the station to which they are assigned.

The shop section of the control board makes provision for showing whether the truck is in for a complete overhaul, is waiting for repairs, whether it is in our own or an outside paint shop, and the number of trucks that will be ready for service in half a day's time. Accurate record is kept of all truck movements and the time out of service for any reason.

Selection of Driver. In the operation careful study has to be made of various factors. Particular care must be exercised in the selection of a driver if the operations surrounding the various factors laid down are to be successful in the selection of an operator.

In the early days, it could safely be stated that the success of a machine was largely dependent upon the operator. That is not true today, however. Some outfits will stand more abuse than others, yet it is well to select an operator who is so constituted that he has the interest of the business at heart.

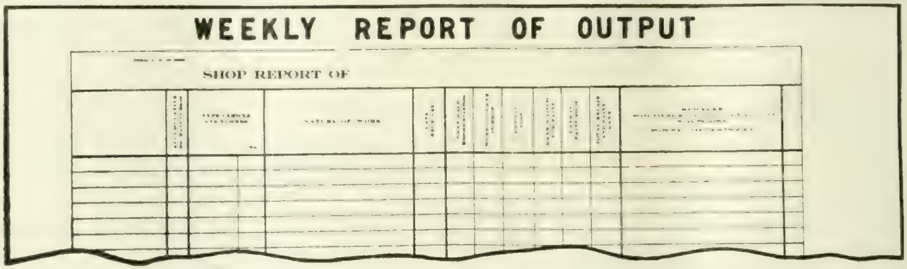


Fig. 3.—Weekly Report of Output of Shop.

An operator should have personal obligations which will tend to instill a sense of responsibility and make him careful of the equipment he operates. In my opinion, a man of 33 years of age or upward, who has a family or some other obligation, if carefully broken in from a mechanical standpoint and instructed along pertinent lines, will assist in many of the operations that make for economical deliveries.

While a general study of the various factors that enter into delivery is the duty of the supervisor or route man, yet it is a fact that through education and co-operation, an intelligent operator will promote economical operation from many angles, particularly when he comes in contact with the public.

In an operation such as road construction, where a certain amount of skill is required in the laying of material such as asphalt or other road material, a careful, conscientious operator will, with some instruction, take on, as a matter of pride, the study of various conditions which will impress the supervising officials and relieve you of many minor duties. An operator of this kind takes pride in his work, cuts down the amount of supervision necessary, and results in greater output, accurate reports, etc.

Provision is made for the operator to have a given time each week to go over chassis, lubrication and other parts that may need attention. The operator has outlined to him the parts of the mechanism he is responsible for which are indicated by an asterisk (*) being placed beside these items on the inspection report. When the operator encounters trouble he cannot solve he turns in one of these reports.

Vehicle Inspection. No vehicle should be installed and left in the hands of the operator without some provision being made for it to receive a periodical mechanical inspection. Inspection is the means of taking care of minor adjustments that are made necessary by the constant vibration and natural wear which any machine is subjected to. It provides a means for taking the "stitch in time that saves nine," and eliminates the possibilities of minor adjustments rapidly becoming worse and eventually resulting in major repairs.

The type of inspection system to employ depends to a large degree on the fleet under consideration. Our inspection force consists of a body of men who are first-class repair men who have the faculty and personality to instruct and assist the operators or marketing men with whom they come in contact. They are held responsible for the mechanical operation of the truck from its installation as a new unit, or after its overhaul until it is ready to be returned to the shop.

They maintain constant schedules and visit a truck periodically. One inspector will take care of from 15 to 24 vehicles, depending on the type, the amount of territory they have to cover, for it is obvious that a man can take care of a much larger number of vehicles operating from a central garage than one who has to visit a number of plants or stations.

Besides being responsible for the mechanical condition of the truck, our inspector has to examine for proficiency all men who are employed as operators. He is held responsible for any neglect which may result in our having a vehicle go on the road which presents other than a first-class appearance, and reports any irregularities and indifference exhibited toward the rules that are laid down for the motor vehicle operators' guidance.

Overhauling of Trucks.—Provisions are made to overhaul the vehicles when needed in a central repair shop, of which an organization chart has been shown. Outfits are brought in for repairs during off seasons, or are replaced by "reserve" equipment, which is held for this particular purpose. Every effort is made to plan the movement into the shop so that the outfit will receive prompt attention. The progress of the work is checked by a weekly shop report, illustrated in Fig. 3, which materially assists in checking up the shop activities and provides an index of work accomplished.

To obtain the most economical results, it is best to adopt the unit repair basis. This provides for the carrying of a number of complete units which can be readily substituted for the worn parts, and the worn parts can be undergoing repairs after the chassis is in the paint shop or on the road.

Repair Shop.—The shops are divided into departments such as chassis, motor, gear box, rear axles, electrical, overhaul and a competent specialist is engaged for these respective duties. As a department grows, the old employe should be worked into a position of working foreman. This training should fit him to assume greater responsibilities. I find that more accurate and economical results are obtained under this method than by permitting a man to do all-round work, and, besides, through this system it is possible to detect the source of poor workmanship or failures.

Inspection is provided in each department through the activities of the foreman and final inspection of the complete job is provided for by a man who is entirely responsible to the superintendent alone for the passing out of work.

Repair Parts.—Necessarily in an organization of this kind emergency service has to be provided. This is done by carrying a stock of parts at the main repair shop, and in small quantities at strategetically located points. At the main station this stock-room provides for the shop needs, which facilitates repairs. In any organization where constant service by the vehicle is an asset, an efficient stock or service depot is a wonderful thing. It provides a means for filling wants in any emergency which places the vehicle in a position to operate at all time.

To provide proper service it is necessary that correct mechanical information be kept on file, and changes in the mechanical condition of a vehicle kept up to date. We provide for this by having a comptete set of specification sheets, furnished by the vehicle manufacturer, which is filed with a standard mechanical information sheet. If these records are properly maintained the service man has a ready reference for each vehicle, which will remove a great possibility of incorrect parts being supplied.

Painting Trucks.—A well-kept truck should be kept painted periodically. Paint protects the wood and metal surfaces from the elements, and provides a means for increasing the value of the vehicle by making it a traveling advertisement. As I travel I am often surprised to note that some concerns pay many dollars for select sign locations along highways, etc., and then neglect their motor equipment. If advertising pays, I can conceive of no better medium than a well-kept vehicle which daily encounters many more people than the average signboard.

A paint shop should be well ventilated, have dust proof varnish rooms, and have facilities for rapid drying, although some wonderful results are accomplished along these lines by small shops with limited facilities.

Accounting.—That the officials may know just what each vehicle is doing, and be provided with a basis of comparison with other mediums of transportation, accounting is necessary. Any system should be as simple as possible, yet provide a clear and distinct method of comparison. We do this by summarizing our entire figures on a form. This form analyzes where the money is spent on the vehicle, and the results are shown in groups, by makes, capacity, style of service, and year of installation. It is a progressive record from which can be determined a group performance after a number of years' service as compared with its first year. This is a semi-annual report.

Care is taken through a carefully prepared primer, to see that proper distribution of charges are made.

To compile this report necessitates a group of auxiliary forms, some of which show in minute detail the efficiency of the department, or work being performed. These include:

Delivery,
Mileage run,
Gasoline consumption,
Stock-keeping records,
Analysis of distribution in the central shop,
Analysis of inspectors' time and expenses,
Tire records,

and others from which we can minutely dissect the vehicle's efficiency from any angle that might be required.

Tire Records.—Accurate records are kept of the various types of tires used. Tires are bought on an adjustment, or on a guaranteed price per mile basis. In order that the tires may be properly adjusted and that we may be in a position to compare the relative merits of one make with another, it is necessary that these records be maintained.

Provision is made for taking care of the various types of tire equipment. In the case of solid or cushion tire equipment, a report is made when a tire is applied and its record is kept in the office on the solid tire record. In the case of solid or cushion tires, when once applied to a wheel, they remain there until finally worn out, with but few exceptions. These records are easy to keep as compared with those necessary for pneumatic tires.

Pneumatic tires, which are apt to come to grief through puncture, etc., require more detailed care on the part of the operator, and to assist him in keeping proper records we supply a definite set of forms. These forms facilitate the operator keeping an accurate record, and when a tire is sent in to a central stock room to be adjusted, it is taken care of through a special form of tag, which is used as a shipping and mailing tag. This tag is so arranged that it can be torn in sections when about to be used, and one of the stubs bearing the same serial number as that part which has been sent through the mail and on the tire, is retained by the operator. Through this tag we are able to check shipments and mileage very accurately.

While it may seem to some that the expense involved is not justified, my experience clearly shows that accurate records of this description should be kept. It is surprising to note the large saving that can be effected with some types of tires as compared with others, both from a standpoint of tire cost per mile, and mechanical or repair cost per mile.

A summary of the mileage obtained from all tires is made up semi-monthly and turned in to headquarters. These records give us a comparison between the different types and makes of tires.

Provision is made through these detailed reports, for the various executives of the organization to keep in intimate touch, through analytical forms.

Accounting forms may be obtained economically from various sources, and in the majority of instances under standard methods laid down it will be found that approximately two-thirds of the charges are so-called "Fixed Charges," and one-third "Variable Charges."

I call this to your attention, because if economy is to be obtained, the moving load and active factors are the ones which should receive close attention. Because a vehicle is a mechanical device these are often overlooked, and great stress is laid upon the maintenance and up-keep factors. These latter factors in modern machines will remain practically constant, provided speeding and overloading are eliminated.

The problem of material transfers and interurban delivery by motor trucks, and the feasibility of establishing motor buses is becoming more generally recognized by some of the larger companies. This is indicated by the desire of some of the larger of the railroads and transportation companies having [illegible] of unit carriers, which can readily be transferred to motor vehicles. One such installation I understand is being made by the Erie R. R. for the transfer of material between its Jersey City yards and New York City, and I believe other railroads have similar installations in mind. Traction companies are realizing that the buses can be adopted with profit, to act as feeders for its main trolley lines. These installations are being made only after a careful study of all angles pertaining to the problem and there is no doubt but what the future will bring forth a considerable growth along these lines. The possibilities of this type of transportation call for greater cooperation among all affected, and the industry as a whole should not be judged by past performances of many irresponsible operators, who, because of selfish interests, have not taken into consideration the rights of the public at large, which resulted in abuses springing up that have caused a general feeling of hostility towards this type of transportation. There is need for a greater cooperation if the operating problem is to be satisfactorily solved. Excessive taxation and restrictive laws which seem to be springing into existence over the country, will only result in the throttling of an industry, which is yet in its infancy.

The Modified Construction Contract of Georgia Highway Commission

During the seasons of 1920 and 1921 great difficulty was experienced by the State Highway Department of Georgia in securing satisfactory bids for road construction, due largely to the unsettled condition of labor, uncertainty of materials and high prices, but principally to the lack of sufficient capital among the local contractors. To meet this unusual situation it was found necessary to devise a new form of contract which would be liberal enough to appeal to the contractor, yet give protection to the highway department and to do this a form of bonus and penalty contract was drawn up. This contract was described in the May 4, 1921 issue of Engineering & Contracting. Some further details of the contract and some results obtained by its use are outlined as follows by W. R. Neel, state highway engineer of Georgia, in the April issue of The Constructor.

The Georgia Form "B" contract differs essentially from the so-called "cost plus" contract in that the work is let on competitive bids; the contractor is furnished an incentive to do the work economically and efficiently, and both the contractor and the highway department share in the losses or profits. As all funds for labor and materials are furnished by the highway department the contractor is relieved of the responsibility of financing the work and can devote his entire attention to his organization. Under this form of contract bids are submitted on work in the usual manner and awards made to the lowest bidder.

Preparing Bid and Figuring Profit.—In preparing a bid the contractor works up a unit cost on each item, considering only the expense of labor and material. He also submits a bid covering the rental of equipment and small tools that he proposes using. These two bids combined constitute the "cost of work" and include all items of expense necessary to complete the work, with the exception of a superintendent who is furnished by the contractor. In addition to the "cost of work" the contractor bids a compensation which is called a lump sum or [illegible] per cent of the cost and represents his profit.

In the event that the job is completed for less than the estimated "cost of work," the contractor receives the full amount of his fixed compensation and in addition 25 per cent of the amount saved, provided, however, that the amount does not exceed 50 per cent of the total compensation. Where there is an overrun in costs the contractor is penalized 50 per cent of the overrun up to 75 per cent of his compensation. In this manner the contractor is protected from a dead loss and in the most unfavorable cases will receive at least 25 per cent of his compensation, which is sufficient to take care of his overhead expenses.

This also gives the contractor an incentive to do the work as cheaply as possible, and eliminates the factor of chance always accompanying the straight form of contract. In other words, the contractor is compensated according to the services which he renders and the amount of money he saves.

Select Contractors of High Standing.—It is well to mention in this connection that only contractors of the highest type and moral standing should be selected to handle work under this contract, as an unscrupulous man through his inefficiency or lack of interest and attention causes the work to lag and the cost to run up. It is also very necessary to have absolute cooperation between the contractor and engineer on the work, as a daily checking up of accounts will tend to keep the expense down and detect any weak spots so that the proper precautionary measures may be taken to correct same.

Considering the volume of work let the percentage of overrun has been very small and practically all projects have shown a material saving.

The two projects shown here will serve very well to show the possibilities of the form "B" contract, as the work was let at a time when labor was scarce, freight movements uncertain and prices high.

Saving on a Bridge Job.—Concrete and steel bridge near Blue Ridge, Georgia, received both the regular form and the form "B" bids, the two lowest being $44,433.25, form "A," and $43,346.49, form "B." The contract was awarded under the form "B" bid, and resulted in a saving to the highway department of $4,703.82 and a bonus to the contractor of $1,834.61 above his fixed compensation. The final figures were:

Estimated cost of work	[illegible]
Actual cost of work	[illegible]
Saving	[illegible]
Contractor's share of saving	[illegible]
Net saving to the Highway Department	[illegible]

On this particular project it was found necessary to increase the quantities after construction had started, so the figure, "estimated cost of work," was determined by using the total actual quantities in place and the unit prices bid by the contractor.

Result on a Road Grading Contract.—Union county, 8.778 miles of graded road out of Blairsville, Georgia, was also let under the form "B" contract and shows a very material saving to the highway department and profit to the contractor.

Estimated cost of work	[illegible]
Actual cost of work	[illegible]
Saving	[illegible]
Contractor's share of saving	[illegible]
Net saving to Highway Department	[illegible]

This project is about 30 miles from the nearest railroad station in a very mountainous section of the state, and during some of the winter months the roads leading to it were nearly impassable, making it difficult to haul in supplies and material.

The two low bids, one form "A" and the other form "B," were about $34,000 apart, showing the difference of opinion between contractors at that time as to the value of work. Had this work been let under the regular form of contract the state would have paid about $27,000 more than the work was worth.

The following is a summary of the largest of the form "B" contracts completed:

Total estimated cost	[illegible]
Total actual cost	[illegible]
Saving	[illegible]
Contractor's share of saving	[illegible]
Net saving to state	[illegible]

Had the above contract been awarded under the form "A" contract at the unit prices prevailing at the time it would have cost the highway department approximately $1,625,000 and resulted in a loss of around $200,000.

Minnesota Has Completed Over 1,000 Miles of Federal Aid Road.—Of the 11,017 Miles of Federal Aid Roads completed up to March 31, Minnesota leads with 1,093 miles. Other leading states are Texas, 919 miles, Wisconsin, 657, Illinois, 489, Ohio, 465, and Arkansas, 401.

Adequate Ranking and Parking Facilities for Vehicles

Abstract of Paper Read Feb. 14 Before the National Highway Traffic Association

By W. P. ENO,

Chairman of the Board of Directors [illegible] Highway Traffic [illegible]

The National Highway Traffic Association on May 8, 1919, adopted as its standard the Council of National Defense Code of General Highway Traffic Regulations, as printed and amended to that date, in which the following definitions are given

"Ranking—Standing vehicles behind one another parallel with curb."

"Parking—Standing vehicles alongside one another at an angle to curb."

The term "ranking" is derived from the term "cab rank," as used for centuries in London, where cabs are placed on stands one behind the other in file and the term "parking" from the practice of placing gun carriages parallel to one another in which position they are said to be parked. It is therefore clear that the terms "ranking" and "parking" are not synonymous, but that there is a practical and important difference between the two. We must get these terms clear in our minds before we can treat this part of traffic regulation in a concise manner.

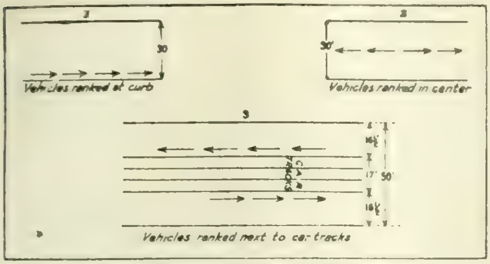


Diagram Showing Ranking of Vehicles.

Classification of Vehicles.—In regulating ranking and parking we must divide vehicles into "live vehicles" and "dead vehicles." A "live vehicle" is one whose driver is present and prepared to move his vehicle immediately, while a "dead vehicle" is one whose driver is absent and therefore unprepared to move his vehicle immediately. A "dead vehicle" is also one which cannot be moved immediately because out of order or for any other reason.

When vehicles are ranked, no one of them can move out of the line independently of the others, unless considerable waste space is allowed for between them, whereas when they are parked, being parallel to one another, any one of them can get away without causing any other one to move.

In considering the question of ranking and parking we must take into account the requirements of the Code of General Highway Traffic Regulations. (See Art. III, Secs. 4, 5 and 6). No part of the Code has had a more careful study by more people. The considerations involved are complicated because it is difficult to preserve the rights of all and at the same time refrain from imposing more restrictions on any one than is absolutely necessary. There is no reason why a vehicle should not rank or park anywhere provided that in so doing it does not unreasonably restrict the liberty of others. See Sec. 5 of Art. III of the Code, which reads as follows:

"A vehicle waiting in front of an entrance to a building or a transportation station shall promptly give place to an arriving vehicle."

This, of course, requires the driver of the waiting vehicle to be ready to pull out immediately on the approach of an arriving vehicle. Such strictness, as this implies, is absolutely necessary on roadways where the importance of getting to the curb is paramount, as for instance, on roadways devoted to retail trade and to a slighter degree, on those devoted to residences. Where wholesale business predominates the necessity of allowing sufficient time to load or unload has to be adequately considered. In this case, Sec. 6 of Art. III of the Code is the regulation which applies. It reads

"A vehicle, when another vehicle is waiting to take its place, shall not remain in front of the entrance to a building or transportation station, except while expeditiously loading or unloading, and, if horse-drawn, and with four wheels, the horse shall stand parallel with the curb, faced in the direction of traffic."

In enforcing Sec. 5 and 6 of the Code, it should be noted that a vehicle ranked or parked is out of the way of moving traffic and should not be compelled to enter it again until another vehicle comes to take its place. It is a case where the old adage, "Let sleeping dogs lie" applies. It is clear that while these provisions of the Code should be enforced strictly when congestion exists they need not be so strictly insisted upon when congestion does not exist. Of course, every driver, out of common decency, should refrain from leaving his vehicle where it will block access to the door of an occupied building.

General Ranking and Parking Spaces.—There are many spaces which can be used for ranking and parking without interfering with the flow of traffic on the roadway. These should be regarded as general ranking or parking spaces. (See Sec. 4 of Art. III, which reads as follows.:

"Sec. 4. A vehicle shall neither rank nor park so as to prevent the free passage of other vehicles in both directions at the same time; nor in one direction on a 'one-way traffic' roadway; nor with any part of it or of its load extending beyond limit lines; nor within ten (10) feet of a fire hydrant."

Such spaces are better marked out by paint limit lines, but whether marked or not marked, they should be free for vehicles to rank or park in. Among such spaces are those alongside parks, vacant lots, public and vacant buildings and buildings where the doors or entrances are not in regular use. Briefly, these spaces may be defined as all those not in front of a regularly used entrance to a building or to a transportation station.

No private signs prohibiting ranking or parking should be allowed, but the police department should furnish signs on application of property owners if the reason given is adequate. All signs, like everything else in traffic, should be standardized. The signs for stationary vehicles, designating parking spaces, cab-stands, car and bus stops are known as secondary signs and should have black letters on a vivid yellow background.

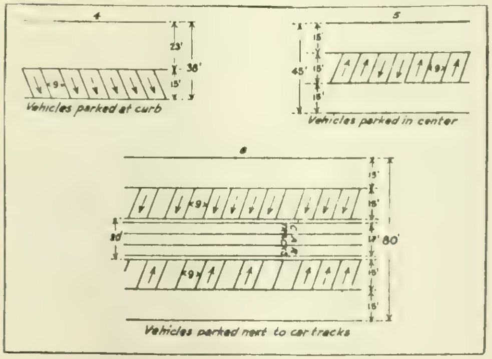


Diagram Showing Parking of Vehicles.

The economy of room for waiting vehicles as well as for moving vehicles on many congested roadways is so important that it is well worth while to define by paint lines every such space that can be used to hold one or more vehicles.

Special Ranking and Parking Spaces.—Besides the general ranking and parking spaces already described there are others, especially adapted to provide for waiting vehicles. Some of these are in the center of streets; some, in very wide streets are next the car tracks and others are where streets come together at acute angles. These spaces are often of irregular shapes, filling space not required for lines of moving vehicles. It is of the utmost importance that all such available spaces in the congested parts of cities be scientifically marked with paint limit lines or be paved with a different kind of pavement from the rest of the roadway and furnished with signs with the words "Public Ranking Space" or "Public Parking Space," as is best adapted to the local possibilities. In these spaces vehicles should usually be allowed to remain indefinitely unless at certain hours it is necessary to limit their time, when the sign should have on it such additional wording as is necessary, as for instance, "Thirty Minutes from 3 to 7 P. M."

Parking spaces should have stalls not less than 8 ft. or more than 9 ft. wide for vehicles marked by paint lines. Stalls for trucks, sight-seeking vehicles, etc., should be wider.

Vehicles should be parked at an angle to the curb of 90 degrees, 45 degrees, 37½ degrees or 30 degrees, as is best adapted for local conditions. The width of a parking space located in the middle of a street, where vehicles are to be parked at an angle of

90° should be at least 15 ft
45 should be at least 15 ft
37½ should be at least 14 ft
30° should be at least 13 ft

When the parking space is next to the curb these widths can be reduced 1 ft. each, respectively, as a portion of each vehicle can project over the curb about that much.

Vehicles should never be parked at an angle of 90 degrees to the curb except in certain locations when waiting for the termination of the races, theater, etc., or when loading or unloading merchandise, and in some instances on cab stands. In parking at an angle of 90 degrees to the curb it is apparent that to get into a stall in the parking space will very often necessitate backing once or even several times.

When vehicles park they should drive directly into their stalls and back out when ready to leave. This method will avoid seriously retarding other traffic if the time chosen to back out is when there is a slight let up in traffic.

If the opposite is done, i. e., passing the stall to be occupied and backing into it, it must always retard the vehicles which are directly behind.

Ranking spaces in the middle of a street should have the side lines 6 ft. apart. If at the curb, one line 6 ft. from the curb should be used.

Some streets are wide enough to park on both sides and allow the necessary room for moving vehicles in the center. Others can have vehicles parked on one side and ranked on the other, provided room is left for moving vehicles.

In one-way traffic streets, if a parking space is to be marked on one or both sides, the stall lines should slant towards the approach of traffic.

Cab, Hack, Truck and Sight-Seeing Vehicle Stands.—Cab, hack, truck and sight-seeing vehicle stands should be marked by signs giving the number of such vehicles each stand is intended for. The vehicles should be ranked usually in the middle of the roadway or next the curb, as best suits each locality. There are, however, a considerable number of places where vehicles can be parked advantageously either in the middle of the roadway or at the curb. At such places an angle of 90 degrees is ordinarily to be preferred, as it best enables such vehicles to leave the parking space so as to proceed in either direction with equal facility. However, this is not always the case. Sometimes such stands are located in the center of the roadway, where, if other vehicles are ranked at the curb, there is not sufficient room for entering or leaving the stand to join in with the moving traffic without maneuvering by backing and thus impeding it. In this case an angle of 45, 37½ or 30 degrees should be substituted.

When parked at the curb public vehicles should be backed into the parking space so as to be ready to drive directly out into the traffic when leaving. The latter method is exactly opposite to what is advised for usual parking spaces.

This paper has been written for technical men, especially for those who are making a study of traffic regulation as a branch of civil engineering. In the not distant future, these [illegible] will be given positions and they will be employed in the enforcement of such work. Only by specialists can complicated traffic problems be solved and the problem of providing for the accommodation of the greatest number of waiting vehicles in a given space on the highways and in specially constructed storage places is one of our greatest civic problems today. The time when such things are left to inexperienced members of police departments or of so-called traffic advisory committees is about over.

Getting Ready for the Pavement

Preparatory Steps in Extension and Repair of Surface and Sub-Surface Structures, Described in Paper at City Paving Conference, Philadelphia

BY R. A. MAC GREGOR,

Engineer, Department of Public Works of Manhattan Borough, New York City

I shall treat the subject under five heads:

1. Planning of all new municipal surface and subsurface structures not yet installed
2. Securing the necessary funds for these in addition to the paving appropriation
3. Letting of contracts for these if of sufficient magnitude to be done in separate contracts from the paving.
4. Notification of all public utility corporations of intention to pave and requiring construction ahead of business demands to avoid openings for one or more years.
5. Notification of all property owners to repair or do other necessary work to their sewer and water connections, etc.

This later may entail considerable work if the roadway is to be widened and vaults altered.

Examination and Repair of Sewers and Water Mains.—It is the duty of the city or town to have all its own subsurface work completed before paving or repairing is done. This will include the examination and repair of all sewers and water mains including fire hydrants.

The sewers, if large enough, should be carefully examined from the inside, and if pipe by means of lights and mirrors, from the manholes. This examination should enable the engineer to determine whether the sewer will need repairs, barring accidents, within 3 or 4 years. It will often be found that short lengths are in bad condition requiring opening of the street surface and rebuilding the arch or the entire sewer. If a pipe sewer shows sign of collapse or bad alignment, opening from the surface cannot be avoided.

If the sewer is of brick, 3 feet in diameter or over, repairs can be made from the inside and the sewer given a new lease of life. A great deal of this inside work is done in Manhattan on brick sewers 50 years old, from 3 ft. 6 in. x 2 ft. 4 in. egg-shaped upwards. The inner ring of 2-ringed sewers is often replaced.

Next in importance of the city's structures are the water pipes. These should be tested for leaks by bar holes along the line of pipe. The audiphone, or similar appliance, does not discover small leaks at joints, for instance, which may soon blow out and cause much damage. If a new main is required, either to replace a defective one or to give larger capacity, all services will have to be changed to the new main. This may mean cross cuts every 25 or 30 ft. on both sides of the street.

As a special appropriation may be needed for this work, it is important that the financial matters be attended to in time to co-ordinate with the paving program. The repairs to hydrants, of course, are included in the work on water mains.

It may also be necessary to provide new or increased surface drainage with inlets and receiving basins. This will require at least short trenches to reach the sewer if a combined system is in use and possibly longitudinal trenches if a separate system is used.

In towns provided with sewers an under-drainage system is not generally needed as it is on country roads. The trenches for sewers, water pipes, etc., give enough drainage to prevent damage to pavement by frost or boggy and marshy spots.

Underground Lines of Public Service Companies.—Notification to all subsurface corporations of intention to pave and the approximate date of beginning that work. These corporations should be encouraged, if they cannot be forced, to build sufficient new lines to provide for estimated future business, say for 5 years at least. They may be encouraged to do this by relieving them of the cost of any repaving over trenches, whether for new lines or repairs to existing lines, if the work is done before the city begins repaving. For some years the corporations in New York City did a great deal of this advance work to the profit both of themselves and the city. For about two years, however, owing to a difference in policy between the department having control of electric and gas companies and the authority charged with the upkeep of the city's streets, this advance work has been almost entirely stopped.

One New York company alone laid 108 miles of electrical subways—not duct miles but subway miles in the years 1915, 1916 and 1917 ahead of new paving and in anticipation of future business. From the records of the use of these duct lines it is calculated that had the advance work not been done over 12 miles of trench would have been opened within one year of completion of the 15 to 20 miles of pavement laid the previous year. The need of one authority in charge of streets, determining what structures shall be laid in the street and in what location, as well as maintaining and laying the pavements, is evident. The later policy referred to has cost the city a great deal and the community much more by the duct work having been done piecemeal.

Use of Space Under Sidewalks. The use of the sidewalks for the accommodation of all distributors should be considered. This would reduce the interference with the roadway pavement and vehicular traffic. In Manhattan the roadways are in many streets so filled with pipes and duct lines that it will soon be necessary to use the sidewalks or build at a deeper level entirely below all sewers and sewer connections. At present the upper level is being used; that is, above the sewer connections and below the water connections. The policy of preserving the sidewalks for the possible use as vault space by property owners is radically wrong. The streets were acquired for public purposes and electric subways, water and gas mains are unquestionably public utilities and necessities.

The allocation of space in the streets is a serious problem when the space needed for manholes and cable vaults is realized. To allow corporations to follow the line of least resistance and put their structures where they want is foolish, to use a very mild term.

To insure good work in refilling trenches, the corporations are required to restore any pavement over trenches which settles within 1 year. The corporations therefore do careful work in refilling, ramming the earth in thin layers, so there is not a great amount of settlement after repaving.

Street railway work also comes under this head. If the track is underground trolley a great deal of excavation may be needed, the yokes and conduit going down about 3 ft. and all encased in concrete.

If the track is overhead trolley, the work is much simpler, but more track probably will be in need of attention. In any case the track should be overhauled and possibly renailed before paving.

This is especially important when the roadway pavement extends to the rail, the concrete base and the wearing surface being continuous over both the city and railroad avenues.

Gas mains should be tested by bar holes down to the main at every joint. A very slight leak will then reveal itself to a man with a good smelling apparatus. Repairs to gas mains usually entail the uncovering of every joint and every service pipe. This cuts up the subgrade seriously, the joints being about 12 ft. apart and service about 25 ft. apart. In one avenue I recall two 36-in. mains run parallel in one roadway 22½ ft. wide from center to rail. Openings at each joint on each main were made, usually alternating, a joint in one line being opposite the middle of the other pipe. The work was nearly a mile long, but the back-filling was so well done that I doubt if an indication of these holes can be found. Other streets do not all furnish such good examples, perhaps due to different materials in the roadway subgrade as much as to bad back-filling.

Notification of Property Owners.—In Manhattan it has been the practice for over 10 years to serve a written notice on the owner or occupant of every property fronting on a street to be paved or repaired. The notice states the intention of the city to pave and advises the owner to make any needed repairs or changes to his sewer and water connections before paving work is begun on pain of being refused permission to do this work for 1 year after completion of the pavement. The latter threat cannot be enforced as a stopped sewer or water connection must be repaired for health reasons, but the notices do have effect. No charge for paving over the trench is made, only an amount equal to the cost of restoration being taken as deposit against possible settlement of the back-fill. This means a saving to the owner of $25 to $35. On all other permits for openings by plumbers a deposit of double the cost of restoration is taken, one-half for the first restoration and the other half for a possible second restoration, in case of settlement. If this second half is not used before the expiration of 6 months, it is refunded.

The amount of sewer and water work to be done having been determined, the time needed can be estimated. The corporations should also estimate the time needed to complete their work.

The schedule of work of paving can then be made up and the paving contractors advised of the approximate time for beginning their contracts.

If the surface drainage work is not extensive, merely building inlets and basins, it will be more satisfactory to include them in the paving contract.

The contractor can then arrange his operations to better advantage than if another and probably smaller contractor is doing a little work here and there along the line of the main contract. Both methods have been tried in Manhattan and the contract including both paving and surface drainage work has been found best.

Before concreting is done, and certainly before the pavement is laid, all manhole heads and boxes should be brought to grade. It is usually easier to do this after concrete is laid, especially at intersections, but careful inspection must be given as the concrete around the boxes may not be as well mixed as in the rest of the work.

Wages in Road Building

The following tables from the April 15 Index of the Associated General Contractors show the average rates in cents per hour paid in February on Federal Aid road work:

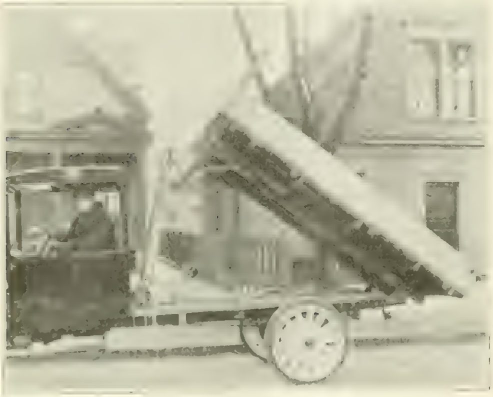
Section of country.	Kind of work.	Foremen			Operators										Skilled labor.		
		Superintendent.	Foreman.	Sub-foreman.	Auto driver.	Truck driver.	Roller engineer	Machine driller.	Mixer operator.	Ste. shovel oper.	Tractor operator.	Jackhammer oper.	Crane operator	Engineer.	Blacksmith	Bridgeman.	Carpenter.
East	Grading	66	50	..	..	.	..	..	..	55	..	..	..	..	..	..	.
North	Paving	84	58	70	..	48	..		..	69	..	..	.	41	40	.	50
Central	Structures	65	50	..	..	..							.	.	.	.	.
West	Grading	70	51	..	..	42	50		..	100	56	..	.	..	..	..	40
North	Paving	81	49	35	..	40	40		..	70	..	..	..	60	50	..	..
Central	Structures	90	54	..	.	42	..		45		50	.	..	50	..	..	52
South	Grading	67	39	..	..	30	.						.	..	25	..	
Atlantic	Paving	150	52	.		45		.	..	60	..	..	67	53	25	100	50
	Structures	100	51	30	25	25	58		35				..	..	35	..	42
East	Grading	93	49	35	..	35	50			50		32		.	30	..	..
South	Paving	80	56	..	25	..	58		50	.			..	..	65	..	
Central	Structures	100	65	35	..	35	..		25				.	25	50	60	29
West	Grading	72	54	77	10	33	..	40	..	135	63	25	.	..	40	..	..
South	Paving	104	63	71	31	33	55	18	62	57	44	49	100	63	46		63
Central	Structures	80	46	70	27	33			34	..	..	62	62	61	48	48	49
Mountain	Grading	106	70	63	.	54	44	50		125	65	.		.	62	..	75
	Paving	103	58	45		55	52			.				61	50		60
	Structures	94	73	72	..	50	[illegible]		55	.	30		.	53	67	50	62
Pacific	Grading	118	72	61	..	62	75	58	..	106	..	..		62	63	..	7[illegible]
	Paving	..	..	..	.	72	7[illegible]		100				87	.			
	Structures	112	85	62	62				75	..	..	..	..	.	60		78

Section of country.	Kind of work.	Skilled labor							Commissary labor					Common labor.		T'ms.	
		Bridge carpenter.	Driller.	Fireman.	Finisher.	Concrete finisher	Mason.	Powderman	Cook.	Assistant cook.	Cook's helper	Flunkey	Waiter.	Common labor	Teamster	Teams.	Mechanic
East	Grading	..	..	..	..	..	..	..	..	..	..	..	..	23	22	..	..
North	Paving	..	..	45	..	..	..	.	32			10		26	42	28	40
Central	Structures	50	..	..	..	..	.					.	..	30	..	..	..
West	Grading	..	..	..	..	.		.	60				.	28	27	40	..
North	Paving	..	..	35	..	.				.			..	28	22	31	60
Central	Structures	..	.	..	.			.					..	32	20	38	50
South	Grading	..	..	..	..	.			10					13	12	..	..
Atlantic	Paving	..	..	20	..	..	..	..	..	..	..	..	..	16	12	..	..
	Structures	..	..	.	.	30		.			..	.	.	16	..	..	30
East	Grading	.		.				80					.	20	18	34	..
South	Paving	..	.	.	45					..			..	16	19	32	..
Central	Structures	50	..			65	80				.		..	18	17	42	50
West	Grading	..	20	..	25	..	..	43	31	22	25	18	.	24	24	42	..
South	Paving	35	..	34		62	50	44	30	17	17	14	35	23	21	42	55
Central	Structures	20	..		25	[illegible]			31	20	.		.	24	22	24	66
Mountain	Grading	.	48	88				77	61	60	30	50	50	39	33	35	70
	Paving	..			50			40	30	35	..	..	..	33	35	25	..
	Structures	58	..	..	..	..	47	..	36	..	..	20	..	36	32	62	.
Pacific	Grading	..	47	75	..	..	..	75	60	..	25	..	..	45	46	..	..
	Paving	.	.		75					..	.	..	..	50	45	..	..
	Structures	..	..	..	..	69	..	..	40	..	25	..	..	46	45	..	..

A Compact and Efficient Hand Hoist

The hoist illustrated herewith on a [illegible]-ton Kissel truck with wooden platform body can be mounted on any chassis, and will satisfactorily handle loads up to [illegible] tons. It is notable for its compactness, adaptability and ease of operation.

The hoist occupies only 8 in. of space back of the cab, and is mounted on supports which allow it to incline toward the body when the body is raised. The heavy springs on the centre pins, allow it to move over gradually as the weight is increased. This inclining of the hoist gives a greater dumping angle as well as decreasing the efforts of the operator who raises it.



Heil Hand Hoist.

There is a handle just above the ratchet wheel which is used as a means of operating the friction brake for checking the speed at which the body descends. The weight is 290 lb. complete. The hoist is made and furnished complete by the Heil Co., Milwaukee, Wis.

An Improved Wheel Scraper

Many improvements in the design and construction of wheel scrapers appear in the new "Roytrac" made by Smith & Sons, Kansas City, Mo. The new scraper has been made decidedly heavier than the original of two years ago. It is said that these scrapers as now built will withstand the heaviest of draw-bar pull and many tests have been made to show that they will perform under unusual conditions. Another feature, not new but important, is the 6-in. concave special wheel, now regular equipment, which eliminates slipping and sinking in soft dirt and sand.

Tractor-Scraper Outfit.

The universal joint and stabilizing springs have been greatly improved and are combined into one unit. This unit is used between scrapers when more than one scraper is used behind the tractor and keeps the scrapers in perfect alignment. It also eliminates all unnecessary play either side or up-and-down. This unit plays an important part in securing correct tracking either on the straight haul or in making turns. A train of four Roytrac scrapers will turn in a [illegible] circle.

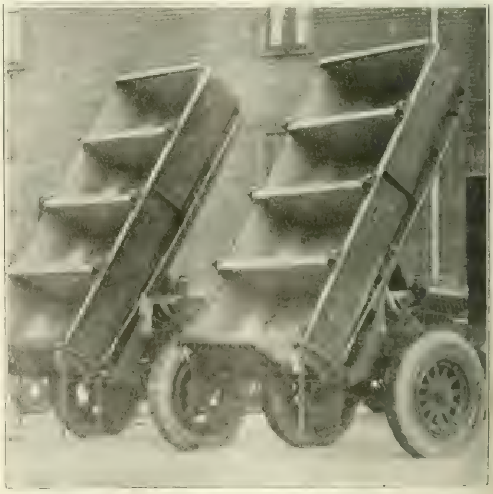
Paver Equipped with Rubber Tires

The use of rubber tires is an interesting feature of a motor-driven Rex Paver recently completed by the Chain Belt Co., Milwaukee, for a street railway company. This machine is to be used principally for paving between tracks where the paving outside the tracks has been previously completed. The tires prevent damage to the finished paving as the machine moves along with the job. Also, in traveling from job to job over highly finished city streets the paver can be moved at a good rate of speed without danger of damage to either pavement or machine. Two sets of tires are used on each of the front wheels, each tire 34 in. x 6 in., or a 12-in. width for each wheel. On the rear wheels, single tires 40 in. x 12 in. are used. These are fitted to heavily constructed wheels which are driven by a steel bushed roller chain of the Chabelco type.

Rex Paver Equipped with Rubber Tires.

Partition Fitted to Any Standard Truck Body

The usefulness of the partitioned truck body has developed rapidly, and many owners of standard bodies will be gratified to learn that they can install partitions in their present equipment and thus avoid the necessity of purchasing complete new partitioned bodies.



Partitions In Model R. S. C. Bodies on Mack Trucks.

The Heil Co., Milwaukee, Wis., makes a swinging partition which can be installed on any standard steel dump body, providing the height and width as well as the model of the body are given. This partition is operated by means of a lever attached to an eccentric roller operating in a bearing which raises the partition vertically until it clears lugs in the bottom of the body. When the body is raised, the partition swings outward allowing the compartment to be emptied. One man can operate it very easily. Bodies can be fitted with as many partitions as desired. The eccentric bearings are bolted to the sides with two bolts. These can be removed making the body again a standard dump body.

Method of Surfacing Roads with Chert*

By E. A. EUBANK,

Resident Engineer, Tennessee Highway Department

Chert is a composition of rock and clay. The rock portion may be, either entirely or collectively, particles of flint rock, limestone, sandstone and chalk, ranging in sizes from $\frac{1}{4}$ in. up. The clay should have a gummy consistency and be free from sand and loam. The chert found in Benton, Henry and Decatur counties, Tennessee, is composed for the greater part of clay and flint rock with a small percentage of soft, white and pink stone which may be called chalk. The clay content of this chert varies from 15 to 30 per cent. Chert acceptable for road metal should not contain more than 25 per cent of clay or, on being compacted, develop a shrinkage factor of more than 35 per cent.

Materials of the above percentage can be used on secondary types of road construction where otherwise it would be necessary to use a foreign material for surfacing, and on primary roads it may be used as a base course. Chert with a greater percentage of clay or a shrinkage factor of more than that specified above can be economically used as a road metal in districts where such material can be obtained within a reasonable distance from the right of way of the proposed project. Chert of the latter class is found in practically all the counties through which the "divide" between the Tennessee and Mississippi Rivers cross.

Classification of Chert.—The chert with a clay content of between 15 and 30 per cent will be designated as Class "A," and that having a percentage of clay over 30 per cent as Class "B." No set rule can be applied to the placing of Class "A" chert surfacing, as each square yard of material placed varies in its proportion of stone and clay, sizes of stone, and the moisture content of the clay.

An important feature of chert, very often overlooked or treated lightly, is the proper inspection before it is placed on the roadway. An easy and very convenient method of testing chert in carload lots is by walking upon it. If it consists of the proper proportions of stone and clay a crunching sound can be heard denoting that the clay coating on the stone is not so thick that the sound produced by the grinding together of the stones is not deadened. If too much clay is in the chert this sound cannot be heard.

The above tests are made on the assumption that the stone is acceptable and are only for the purpose of determining the quantity of clay and the advisability of making more extensive tests.

As a perfectly-shaped subgrade is the mold of a finished surface for any class of surfacing material, too much importance cannot be attached to the absolute necessity of having a perfect subgrade when using chert, as this class of material varies both in size and quantity of stone, as well as the quantity of clay binder.

Spreading the Chert.—After the subgrade has been properly prepared, careful attention must be given to the spreading of the chert. It is very necessary to give attention to the depth of the chert in its loose state in order that the desired thickness after thorough compaction may be obtained. In advance of the spreading of the chert all rock that does not conform to the requirements of the specifications in regard to size should be broken up and placed on the subgrade. The best tools for spreading this material are shovels, forks and rakes. When a load, either wagon or truck, has been dumped on the subgrade, the entire load should be distributed since the load was dumped more or less in a body from a height, causing a perceptible degree of compaction which will develop into a high place when this load has been spread out with forks and rakes, to the desired thickness and then rolled. A greater percentage of compaction will be obtained by placing chert over a certain area a shovel full at a time than when chert sufficient to cover the same area is dumped bodily from a height of 3 or 4 ft.

Compacting.—After spreading a short section of chert surface, two or three rounds with a roller should be made. When this is done all the holes and little irregularities which develop on rolling should be taken care of, by first loosening up the surrounding materials and then filling with additional chert. The direct cause of these irregularities is that each square foot of chert surface placed does not consist of the same proportional parts of stone and clay.

The clay binder should be damp enough to facilitate thorough compaction but not so wet that the clay and small stone will be pulled in small sections by the wheels of the roller as they pass over this surface in rolling. Boards or forms of sufficient height should be used to hold the chert in its loose state before compaction is obtained. Better results and a more uniform surface can be obtained with the chert if it is placed on the road as a single course, as a greater height is convenient and desirable to take care of the stone of unequal sizes.

Construction should begin with the longest haul and should be the farthest point from the base of supply, each day's work decreasing the length of haul, thus eliminating the necessity of hauling over the green chert, making ruts and holes that will result in the necessity of reshaping the surface and re-rolling.

The rolling of a 1-course surface should be done carefully and systematically on account of the elastic condition peculiar to this class of material. It should be rolled from one edge to the center and then from the other edge to the center, overlapping one rear wheel on each roll. This fact should not be overlooked; chert is a natural mixture of stone and clay, and different details in the placing and working of it will always arise and must be met immediately with changes in material and methods of construction which will remedy these conditions.

The inspector should dig test pits in every completed section to determine the depth of compacted chert. In places that are found to be less than the required thickness, the surface should be loosened up before additional chert is placed thereon, in order to secure a good bond between the two layers.

After two or three rounds with the roller, a grading machine with a blade set at about 45 degrees to the center line of the road should be used. The blade set in this manner will deposit the cuttings shaved from the high points into the low places.

Some "Don'ts" in Surfacing with Chert. — The following "don'ts" are always applicable in the construction of a chert-surfaced road:

Don't roll the chert when too wet.

Don't fill up the little holes and irregularities in the subgrade with chert. You can save the cost of the chert and freight by using earth. Another reason is that your laborer has not the time to hunt these places in time to either decrease or increase the thickness of the loose chert.

Don't lay a section of the surface with the idea that the holes, etc., can be filled at a later date and the desired results—a smooth surface—be obtained. Keep the finished surface finished.

Don't try to roll down a high point. Fill up the hole. The low places denote an excess of clay.

Don't roll dry chert.

Class "B" chert is an economical surfacing material if it can be obtained within a short distance of the road to be improved.

With the knowledge that the rock has a strong resistance to wear, and knowing the amount of money available, no trouble should be experienced in determining the advisability of using this class of material. Very often it is a question of how much rock is needed and not of the clay binder. The methods of working this class of material do not differ from the method of working the Class "A" material, but more rigid inspection should be given the material and especial attention paid to the rolling.

The life of a chert surfaced road depends almost as much upon the degree of compaction obtained by rolling when the chert was placed as it does upon the percentage of rock it contains.

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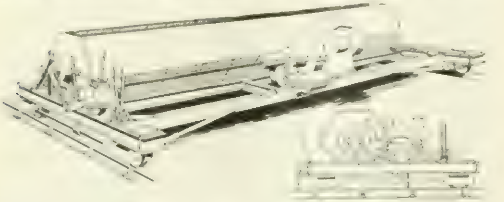
*From Tennessee Highways, official publication of the state highway department.

New Concrete Distributor for Road Building

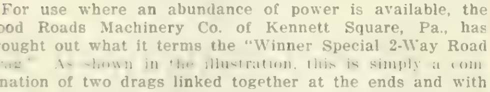
A new unit for road building outfits designed to do away with boom and bucket or swinging chute distribution of concrete on the roadbed has been brought out by the Austin Machinery Corp., Railway Exchange Bldg., Chicago, Ill. The new distributor consists of a trough-like receptacle mounted on a carriage and driven by a small gasoline engine. The distributor runs on the forms. It receives the entire batch from the mixer spout. The trough is kept in a constant state of oscillation all the while that the machine is being run back on the forms, and right up to the moment when the concrete is dumped. In effect it continues and prolongs the mixing process. Arriving at the spot where the concrete is to be dumped, all the operator has to do is to throw into gear a clutch which turns the trough upside down. The result is a ridge of concrete, spread over the entire space from form to form. Then, as the machine starts back to the mixer for its next load, its strike-off board, adjusted to the proper crown, spreads the concrete and smooths it down to the desired level. The distributor thus does mechanically what heretofore has had to be done by several men with shovels and hoes. Moreover it is stated to leave ready for the tamper a surface that is far more uniform than can ordinarily be secured by hand labor. A further advantage claimed is that with the distributor in service, the mixer can be set back 30, 40 or even 50 ft. from the finished concrete.


Austin Concrete Distributor.

A Two-Way Road Drag

For use where an abundance of power is available, the Good Roads Machinery Co. of Kennett Square, Pa., has brought out what it terms the "Winner Special 2-Way Road Drag." As shown in the illustration, this is simply a combination of two drags linked together at the ends and with draught chains adjusted to pull them at proper angles. Six mules or a 10 H.P. tractor can handle this equipment to advantage, and as in ordinary work it will cover about 15 ft. of roadway, its advantages are obvious.

The drag complete weighs 625 pounds, and is equipped with four hooks at the rear, as shown in the illustration, so that an extra drag, heavy chain, or a leveling log or board can be attached to the rear for smoothing the roadway behind the drag. As with the single 2-blade and 3-blade Winner drags, the blades on this equipment are adjustable through large angles.

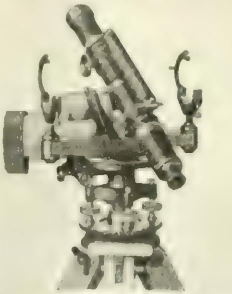

Rear View of Winner 2 Way Drag.

Large Sums Needed for Rural Roads.—Large expenditures will be necessary to bring the two and a half million miles of rural highway in the United States up to the standard of efficiency comparable with their extended use in motor transportation in the opinion of the Joint Congressional Commission of Agricultural Inquiry, whose general conclusions on the subject were announced April 25. It is understood the commission will recommend that Congress continue to provide an adequate program of highway construction and maintenance directed to the more effective correlation of highway transportation with rail and water transportation, and that the states and counties also continue their highway programs with particular reference to farm-to-market roads.

A Quickly Convertible Level and Transit

The accompanying illustration shows the new "Sterling" combination level and transit made by Warren-Knight Co., 136 N. 12th St., Philadelphia, as it is being changed from one use to the other.

This instrument has a 13½-in. telescope, a 5-in. level vial, vernier reading to 5 min., and a shifting plate of full ¾-in movement. It can be converted from transit to level or vice versa in 10 seconds, without the removal of any screw or other parts which can be lost.


Sterling Combination Level and Transit.

Personals

Alexander W. Graham has resigned as chief engineer of the state highway commission of Missouri.

Ralph W. Vincent, Linn Creek, Mo., has been appointed county surveyor of Camden County, Missouri, succeeding Norman A. King, deceased.

Ett S. Smith of Youngstown, O., has resigned as chief of the division of public works in the state highway department of Ohio on account of ill health.

George E. Finck has resigned as office engineer of the paving commission of Baltimore, Md., to accept the position of highway engineer of Greensboro, N. C.

Thomas J. Wasser, state highway engineer of New Jersey, has been elected president of the newly created state board for licensing professional engineers and surveyors.

D. K. Shepard, highway engineer, has been assigned to the sixth district of the Bureau of Public Roads, office at Fort Worth, Tex. He will act as assistant engineer in the office here.

The engineering firms of W. R. Heasler & Sons, Paragould, Ark., and Hiram Phillips, St. Louis, Mo., have been consolidated under the firm name of Hiram Phillips Engineering Co. Offices will be maintained at the Fullerton Bldg., St. Louis, and Bertig Bldg., Paragould.

J. T. Ellison has been appointed second assistant state highway commissioner of Minnesota. The office was created by the last legislature but was not filled before. The appointee will continue also as chief bridge engineer of the highway department with which he has been connected for more than ten years.

George A. Reed, Montpelier, Vt., formerly assistant state engineer of Vermont, has been appointed state engineer, succeeding Daniel O. Young, who resigned to engage in construction work. Mr. Reed was city engineer of Barre, Vt., from 1907 to 1915, and city engineer of Montpelier, Vt., from 1915 to 1917, when he entered the state engineer's department.

Changes in personnel of Wisconsin Highway Commission have been announced as follows: M. W. Torkelson, bridge engineer, has been appointed engineer secretary. W. C. Buetow, assistant engineer, has become bridge engineer, succeeding Mr. Torkelson. In his new capacity Mr. Torkelson will continue his former work except that he will be relieved of all bridge work except occasional consultation work on important structures. W. D. Ryan, now assistant division engineer of division No. 1, replacing Paul Lillard, resigned, and G. E. Eldred promoted to same position on division No. 4 to replace F. L. North, resigned. W. J. Hazelton has been made assistant division engineer in charge of maintenance of division 4.

Manuel A. Sanchez has been appointed surveyor general of New Mexico by President Harding to succeed Lucius Dills when his term expires. Mr. Sanchez was formerly chief hydrographer in the state engineer's office, but resigned to go to Mexico to work for El Potosi Mining Co., Chihuahua, which has one of the largest lead and silver properties in Mexico. When the company closed down its mines a year ago on account of the slump in the silver market, Mr. Sanchez returned to Santa Fe and since then has been in charge of drainage investigations in the Rio Grande valley under the direction of the state engineer's office. Mr. Sanchez is a graduate of the Normal University at Las Vegas and the School of Mines at Socorro, where he studied civil engineering.

Obituaries

Alexander R. Fordyce, Sr., for nearly 50 years a contractor in New York City and Newark, N. J., died April 22, aged 78.

George P. Stirling, a retired contractor of Winnipeg, Man., died April [illegible] at his home, 582 Bannatyne Ave., Winnipeg, aged [illegible].

Benjamin F. Parks, a retired bridge contractor, died last month at his home in Cedar Rapids, Ia., aged 86 years. He had been a resident of that city 49 years, coming there in 1872 to superintend the construction of the [illegible] bridge. He was then in the employ of the King Bridge Co. of Cleveland, but later became western agent for the Youngstown Bridge Co.

Waterworks and Hydraulics Monthly Issue

ENGINEERING AND CONTRACTING

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Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Managament and Office System

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The Relative Increase in Salaries Compared With Wages, and Their Relation to Per Capita Money

By HALBERT P. GILLETTE, Editor.

That white collar employes have not received as great increases in income as blue overall employes has been quite generally known, but statistics have not hitherto been available to show definitely the increase in "salaries" and "wages" respectively.

We have just received from the Bureau of the Census the following statement relative to manufacturing wages and salaries in the year 1919:

Average number of wage earners	9,096,372
Wages	$10,533,400,340
Average number of salaried employes	1,447,227
Salaries	$2,892,371,494

Based on these figures and on corresponding data for previous census years, I have prepared Table I.

TABLE I—AVERAGE ANNUAL WAGES AND SALARIES IN MANUFACTURING INDUSTRIES

Year.	Salary.	Salary level.	Wage	Wage level	Salary and wage	Salary and wage level.
1849	...	...	...	...	$ 248	37
1859	..	...	...	.	289	43
1869	...	...	...	.	378	56
1879	..	...	..	...	347	52
1889	$ 880	64	$ 444	76	484	72
1899	1,046	76	426	74	469	70
1904	1,103	82	477	82	532	79
1909	1,188	89	518	89	590	88
1914	1,380	100	580	100	671	100
1919	1,999	150	1,157	200	1,275	190

Taking the average salary ($1,380) in the year 1914 as being 100 per cent, we see that the average salary in the year 1919 was 150 per cent, indicating an increase of 50 per cent. Taking the average wage in 1914 as 100 per cent, the average in 1919 was 200 per cent, or an increase of 100 per cent. The average of combined salary and wage was $671 in 1914, and $1,275 in 1919, denoting an increase of 90 per cent.

These data make it clear that manufacturing wages rose twice as rapidly as salaries rose during the five years between 1914 and 1919. On the other hand, other data that I have (notably factory wages in New York and Wisconsin, and in the steel mills), show that factory wages have declined rapidly during the past 18 months. It is probable that salaries have been reduced to a less extent, which, if so, would tend to bring salaries and wages more nearly into the relation that existed before the world war. Table I shows that since 1889 the average manufacturing salary has been about double the average wage, except in 1919 when it averaged about 70 per cent more than the average wage.

The Bureau of Labor publishes a wage index, but it relates only to union wages. Union wages, however, change more slowly than do the average wages of factory hands, only a small percentage of whom belong to unions. This is well brought out by the fact that the hourly wage index of union wages was only 155 for the year 1919 as compared with 102 for the year 1914; but for the year 1920 it had risen to 199, and for the year 1921 it was 205. If union wages are slow to rise, they are even slower to fall. None the less, in the long run, union wages move in substantial harmony with factory wages, as the following table shows:

TABLE II—FACTORY WAGE AND UNION WAGE LEVELS OR INDEXES.

Year.	Factory Wage (Annual)	Building union Wage (Hourly)	All union Wage (Hourly)	Average union wage (Weekly).
1899	74	68	.	..
1904	82	82	.	. .
1909	89	95	92	93
1913	...	100	100	100
1914	100	101	102	102
1919	200	146	155	148
1920	...	188	199	189
1921	...	187	205	193

The Building Union Wage Index given in Table II is abstracted from one compiled by Milan V. Ayers, statistician of the Associated General Contractors, and published in Engineering and Contracting, March 22, 1922. It is based on the hourly wages paid in 8 large cities to 11 building trades.

The All Union Wage is one recently published by the Bureau of Labor and "covers the principal trades (union) in 66 large industrial centers."

Table II covers a period of 30 years during which American labor unions have experienced most of their growth, and have shown their greatest aggressiveness. Yet the table shows that factory wages rose at the same rate as union wages prior to the world war, and at a much more rapid rate during the war. It would puzzle Mr. Gompers, I think, to explain this fact. He has repeatedly said that the industrial salvation of the worker depends upon unionization. Yet factory workers (who even now are 85 per cent non-union men and women), prior to 1914 secured as rapid an increase in wages as the most completely unionized of trades, namely, the building trades in the large cities, and during the five years from 1914 to 1919, the average factory wage increased 90 per cent whereas the average building trade wage in 8 of our large cities increased only 46 per cent. Mr. Gompers' argument that unions lead the way in forcing wage advances is thus shown to be erroneous. I have similar wage data back to 1849, when unions were almost nonexistent in America, and the data tell the same story as is told in Table II for the past 30 years, namely, that average union wages have not led but have followed the advances in other wages, and in the long run have merely kept pace with the general wage movement. Let us now compare the average factory wage index with the cost of living index. Table III gives such a comparison:

TABLE III.—RELATIVE WAGES AND COST OF LIVING

Year	Wage and salary index	Cost of Living.	Buying power of income
1849	37	80	46
1859	43	90	48
1869	56	122	46
1879	52	87	60
1889	72	89	81
1899	70	75	93
1904	79	83	95
1909	88	94	94
1914	100	100	100
1919	190	187	101

The "wage and salary index" in Table III is taken from Table I and is the relative annual income of all manufacturing employes, according to the U. S. Census, the average income for the year 1914 being taken at 100 per cent. The "cost of living" is the wholesale commodity price index of the U. S. Bureau of Labor for the years 1889 to 1914; and the Falkner index prior thereto; but for the years 1914 and 1919 the index is the Bureau of Labor "cost of living index." The "buying power of income" is found by dividing the "cost of living index" into the "wage and salary index." It will be observed that between the years 1869 and 1899 the buying power of the average manufacturing employe's annual income increased 100 per cent. Then followed ten years of practically no change; and then came an increase of 8 per cent in the ten years ending in 1919.

I call particular attention to the fact that in one 30-year period (1869 to 1899) the buying power of the average American factory employe doubled. What has been done once can be done again. Science, invention, engineering and business management, if untrammeled by legislation and labor union restrictions, can be relied upon to double the present buying power of the average American in the next 30 years or sooner.

In closing I will call attention to the fact that since 1849 wages and per capita currency have increased in practically the same proportion. Table IV shows the comparison.

TABLE IV.—RELATIVE WAGES AND MONEY AND BANK DEPOSITS

Year	Wage and salary index	Per capita money index	Per capita bank deposit index
[illegible]	[illegible]	[illegible]	...
[illegible]	[illegible]	[illegible]	...
[illegible]	[illegible]	[illegible]	...
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
1914	100	100	100
[illegible]	[illegible]	[illegible]	[illegible]

[illegible] the U. S. [illegible] The per capita [illegible] Statistical Abstract [illegible]

Special attention should be called to the fact that while the wage index and the per capita money index increased in substantial harmony between the years 1849 and 1914, no such harmony exists as to the wage index and the per capita bank deposit index. Yet in 1879 per capita bank deposits were two and a quarter times per capita money, and in 1914 they were five and one-half times per capita money. It is commonly believed that the volume of bank checks has the same effect as the volume of circulating currency on wages and prices. Table IV completely upsets that theory, whereas it establishes the substantial accuracy of the quantity theory of money in relation to wages.

In Engineering and Contracting, April 7, 1920, I gave a correct theory of commodity price levels, and in the Aug. 3, 1921, issue I gave a correct theory of wage levels; so that I shall not now repeat either the theories or the data used to substantiate them. But readers of the last named article may remember that I used daily wage indexes compiled by Falkner and by the U. S. Bureau of Labor, whereas, in this article I use an index much more reliable, not only because it is based on all the wages and salaries paid by all the manufacturers in America, but because it is an annual wage index instead of a daily wage index.

Since Table IV completely upsets the prevalent theory that "credit money" (i. e. bank checks) affect wage levels just as real money (currency) does, I ask bankers and economists either to cease their advocacy of the theory or to show wherein I have misinterpreted the data given in Table IV.

There is at present before America, and, indeed, before the entire world, no more important economic problem than the problem of wage and price levels. It is a problem upon which it would pay nations to employ thousands of economic investigators, if need be. But barely a baker's dozen men in America have been giving this vast problem any real study. All sorts of false guesses (I can not call them solutions of the problem) are prevalent. The daily newspapers repeatedly print such guesses, their editors being apparently guided by the name or title of the author of the guess, rather than by any evidence that the author has spent enough time on this problem to warrant his receiving a respectful hearing.

This article will be sent to the largest daily papers and banks, and to the professors of political economy in 100 colleges, with the urgent request that they give it the most careful consideration.

Can We Learn Anything from the Chinese?

We Americans are apt to think that we can learn very little from foreign countries, and perhaps least of all from China. Yet there are some things that the Chinese have been forced by necessity to study very carefully. We refer in particular to their study of agriculture. The Chinaman probably has no equal as a "truck gardener," not merely because he is a hard worker, but because he has studied the art of intensive farming. The average Chinese farmer "farms less than an acre and supports a large family on it." It is true that the standard of Chinese living is very low, but this should not obscure the fact that we may learn a good deal from Chinese farmers.

More than 80 per cent of the Chinese are farmers. They live in villages, and not on their farms, as a rule. According to E. Stanley Glines, in Stone and Webster Journal,

> China has as many acres in rice as the United States has in wheat and her annual product is more than double and probably three or four times our annual wheat crop, and yet the whole of the rice area produces at least one and sometimes two other crops each year.
>
> Dr. F. H. King, formerly professor of agricultural physics of the University of Wisconsin, in his book entitled "Farmers of Forty Centuries" states that we in the United States have just learned the science of crop rotation, multiple cropping, fertilization, etc., things which have been practiced in China for centuries. The Chinese grow two, three, and even four crops on the same piece of ground each year. In Southern China two crops of rice are grown; in Chekiang Province a crop of rape, wheat, or barley, or Windsor beans, or clover, which is followed in midsummer by a crop of cotton or rice. Outside of Tientsin it is not unusual to see a crop of wheat followed by onions and then cabbage. In one case wheat, Windsor beans and cotton were growing in the same field at the same time. Between rows of wheat ready for harvesting could be seen rows of beans two-thirds grown, cotton had

just been planted. This is a good example of multiple cropping. In doing this the farmer takes advantage of whatever physical, nitro-chemical and biological properties their sowing together may have.

The average rainfall is higher than that of the United States. precipitation occurs mostly in the summer when its efficiency is greatest, from a crop-raising standpoint.

It is estimated that from 300 to 400 tons of water are required in the United States to bring a ton of dry substance through to maturity. From this the amount of water required to feed those millions may be guessed, and particularly when we consider the population density. We see, therefore, how easily lack of water causes famine.

Quick maturing, drought-resisting millets are the staple crops grown wherever water is not available for irrigation. This allows them to secure the maximum returns in seasons of drought and where the rainfall is small.

The Chinese are vegetarians (far more so, perhaps, than any other people) and include a very small amount of animal products in their diets. Hopkins, in his "Soil Fertility and Permanent Agriculture" remarks that 1,000 bu. of grain have at least five times as much food value and will support five times as many people as will the meat or milk that can be made from them. This is perhaps one of the reasons why the Chinese raise so much rice. In the succulent forms of vegetables, the nitrogen content is higher which compensates in part for the loss of meat.

The growing of legumes in rotation with other crops is used extensively for the purpose of fertilizing the soil and this process has been employed for centuries. The theory is that these plants act as hosts for lower organisms living on their roots and in this way help to maintain soil nitrogen. Just before or after a rice crop the fields are frequently sowed to clover.

The Chinese have used irrigation for centuries, and their chief crop, rice, is a crop that requires a great quantity of water.

One of the difficulties that we encounter in our far western states is the tendency of many irrigated lands to become so impregnated with alkali as to kill the crops. Is it not possible that the Chinese encountered this same trouble several centuries ago, and solved it by continually flooding their fields with water in which a food plant would grow? Such a plant is rice.

The Chinese have not been scientific in their solutions of agricultural and industrial problems; but, given several centuries for development, even the most unscientific race will usually discover better means of attaining certain ends. Often the discoveries are more the result of chance than of purpose. This undoubtedly was the case with respect to the Chinese discovery that tea is more healthful than "raw" water in a densely settled and unsanitary community. "Tea," says Mr. Glines, "is another enormous crop of China, and is probably grown to make boiled water palatable." We think that the Chinese did not discover that boiled water was wholesome, and then added tea to it to make it palatable, as Mr. Glines intimates; but rather that tea drinking became a habit in a certain Chinese community, and thence spread to other communities because it was observed that tea topers were not so subject to typhoid and other intestinal diseases. An allied example of chance discovery of a useful practice is the practice of sleeping with closed windows in malarial districts. This was done long before it was known that mosquitoes infect people with malarial germs. Possibly we shall ultimately learn that the Chinese made this discovery also, for their swampy rice fields must be great breeders of "anopheles."

Teaching Men to Think

Teaching students to think and how to think is the great problem of the educator. It is also one of the greatest problems of the business manager, for many of his subordinates are his pupils in business economics. Such teaching resolves itself into five parts: (1) Arousing and sustaining the learner's interest; (2) imparting knowledge of the best methods of answering questions; (3) imparting knowledge of sources of information; (4) habituating the learner to gather, classify, analyze, remember and compare facts; and (5) training the learner in the art of research and experimentation with a view to improving existing methods and devices.

Study of these five means by which the power of thinking can be cultivated discloses that only two of them consist in imparting knowledge, as that expression is ordinarily used. The other three methods used by the best educators are mental training or coaching methods, and they are far more important than the two methods that involve merely the imparting of knowledge. It is because German chemical teachers have been better mental trainers than American chemical teachers that Germany has so far excelled America in chemical progress, both theoretical and applied.

Prof L. E. Akeley, Dean of the College of Engineering of the University of South Dakota, has said: "No very remarkable success is at present achieved in helping the student to become a thinker." Approaching the problem from a psychological point of view, he says:

> The circumstances under which the human being will reason are that he encounters some difficulty that stands in the way of something he must do. The surmounting of this difficulty is his problem, one that appeals to his "felt need." Under no other conditions does the human animal ever reason. In our teaching, efficiency demands that we appreciate these conditions necessary to the reasoning process. The sophomore finds physics a difficulty that he must overcome. If this "must" is simply a matter of "getting by" the student will have gained little that is transferable to the solution of real problems of engineering. If each problem in the physics course has a fairly well-apprehended relation to a felt need of the student as a future engineer, a higher grade of efficiency is secured. * * * * * *
>
> There are two important elements in the reasoning process. First a problem whose solution appeals to a felt need of a reasoning being. Second is the technical equipment, the instrumentalities with which he attacks his problem. The first element, that of the "felt need," must be developed by organizing in his consciousness a co-ordinated group of ends and purposes. These ends are the incentives to vocational interests and choices.
>
> The second element is made up of a disciplinary training in logical, mathematical and experimental devices for solving the problem.
>
> The first element should have a logical and psychological priority to the second, and it must have some priority in time. The student must have the felt need before he can have any interest in the instrumentalities useful in satisfying it. The traditional presentation of physics subject matter puts instrumentalities before the felt need. It is an inversion of the psychological process that fails to produce mental dyspepsia only because the student is more or less capable of protecting himself from the bad methods of his instructor. The difficulty, the problem, should be uppermost in the thought of the student. The instrumentalities should be such, at first, as suggest themselves readily to his mind, or such as the instructor may quite easily suggest to him. After a few problems that have a vital relation to his purposes as an engineer have been solved, the interest thus developed will lead him to some appreciation of the need of more elaborate instrumentalities for the meeting of difficulties closely allied to those already overcome.
>
> * * * *
>
> Another advantage of the proposed method is that in the putting every subject in physics in the form of a "problem," a difficulty to be overcome, and in giving the technical instrumentalities, logical, mathematical and otherwise, a subordinate position in the student's thought, the real spirit of science finds embodiment. Science has advanced in spite of the dogmatism of its votaries. And dogmatism is inevitably engendered when emphasis is placed on the elaboration of theories, of laws, or principles, of definitions. These all assume the appearance of finalities. Not so, when the interest in these is subordinated to that in real difficulties to be surmounted by using these instrumentalities. If a student is at all susceptible to scientific faith he is distinctly discouraged in it by traditional methods. In the traditional presentation these instrumentalities appear as a vast elaborated system whose acquisition is a distinct burden. But when the emphasis is upon the vast array of practical and vitally important problems that a few simple and easily understood principles will readily solve, the latter take on the appearance of wonderful labor saving devices.
>
> Few are they who are trained to the successful use of theory and many are they whose success is handicapped by scientific dogmatism. A man who directs the research work in a large industry told me he would not have technical graduates in his research work. He preferred the Ph.D.'s of the universities. His objection was that the technical graduate would never admit that a thing could be done in any way except the one which he had been taught. His education was a finality.

This last paragraph is especially worthy of careful consideration by engineering teachers. It is not well to generalize from the experience of one director of a research laboratory, but it would be well to make a systematic inquiry among such directors to ascertain whether this director voices a general opinion as to the incapacity of technical graduates as research workers. We doubt very much whether technical graduates are less original than the holders of Ph. D.'s; but we do not doubt that the average technical graduate is still poorly trained as a thinker. Usually he has read no book on logic; and, in spite of the obvious defects of such books, it can hardly be claimed that a study of logic does not improve the thinking powers to some extent. Even if a study of logic accomplished no more than to lead the student to think about thinking it would be valuable.

The greatest defects in present methods of teaching, it seems to us, are two: (1) Failure to arouse sufficient interest in the subjects taught, and (2) failure to habituate the student to search for information with the object of using it to solve a definite problem. To these defects we would add the third that was discussed at length in our issue of May 3, namely, failure to habituate the student to memorize facts with a view to their use in reasoning.

Economic Size of Pipe for Power Purposes

By GEORGE E. LYON.

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The following method of determination of economic size of pipe clearly brings out the relationship of all the important factors. The character of the load curve, and the occurrence of several different load curves (which represent the seasonal or daily variation of load curves throughout the year) is considered. The ordinates of the load curve (power vs. time) are supposed to be proportional to the rate of flow in cubic feet per second. For an existing plant, or one in which the size, number, and efficiencies of the units have been determined, the load curve (power vs. time) could be plotted as q vs. time. In most cases the results agree so closely that it is not worth while to plot the q vs. time curve.

Symbols Used.

$A = A_1 + A_2$.

A_1 = Annual value of energy lost.

A_2 = Annual cost of pipe.

b = A constant such that the weight of the pipe in pounds per lineal foot = btD.

c = Cost per pound of pipe in place, in dollars.

D = Diameter of pipe in inches.

e = Overall efficiency of plant.

e_1 = Efficiency of riveted pipe joint.

f = Coefficient of friction in formula $h' = f \dfrac{L\,v^2}{2gD/12}$.

g = Acceleration due to gravity in feet per second.

h' = Loss of head in feet due to pipe friction.

H = Static head, or head used in finding t, in feet.

i = Interest, taxes, maintenance, depreciation, etc., expressed as a ratio.

k = Sale value of one Kw. hour, in dollars.

K = A constant used in the discussion.

L = Length of pipe in feet.

N = Number of days during the year that the conditions as represented by one particular load curve exists.

p' = Horsepower lost at any instant, due to pipe friction.

p'_a = Horsepower lost at 100% load factor, due to pipe friction.

q' = Cubic feet per second flowing in the pipe at any instant.

Q = Average cubic feet per second flowing in the pipe during 24 hours.

s = Allowed stress (tension) in designing the pipe.

t = Thickness of pipe in inches.

T = Time in hours.

v = Velocity of pipe flow at any instant in feet per second.

W' = Energy lost in horsepower hours per 24 hours, due to varying rate of flow.

W'_a = Energy lost in horsepower hours per 24 hours, due to average rate of flow.

Z = A constant depending on the shape of the load curve.

Using the above notation

$$h' = 12\,f\,\frac{L\,v^2}{2gD} \text{ and } v = \frac{q}{\text{area}} = \frac{(144)\,4\,q}{\pi D^2}$$

$$h' = 6260\,fL\,\frac{q^2}{D^5}$$

$$\text{The power lost} = p' = \frac{(62.5)\,q\,h'\,e}{550} = \frac{q\,h'\,e}{8.8}$$

Substituting the value found above for h', we get

$$p' = 712\,\frac{fLq^3e}{D^5}$$

For a particular installation, $p' = Kq^3$, where $K = 712\,\dfrac{fLe}{D^5}$.

Let us take the load curve as shown in the accompanying sketch as representing the daily variation of load for a proposed development. Its ordinates represent, very nearly, the variation of q throughout the day.

Then $W' = \int p'\,dT = K\int_0^{24} q^3\,dT$.

Also since $p'_a = KQ^3$, we may write the following:

$$W'_a = KQ^3 \times 24, \text{ or } K = \frac{W'_a}{24Q^3},$$

and substituting,

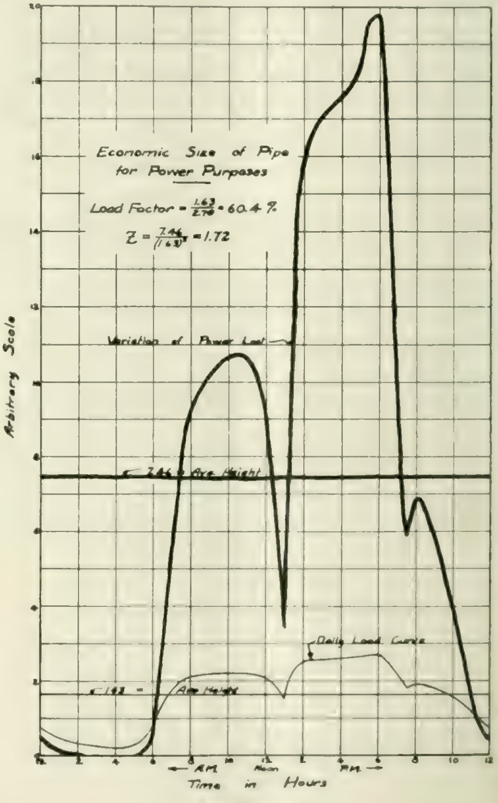
$$W' = W'_a\,\frac{\int_0^{24} q^3\,dT}{24Q^3}$$

$$= W'_a\,\frac{\text{area under } (q^3, T) \text{ curve}}{24\,Q^3}$$

$$= W'_a\,\frac{(\text{average of cubes of } q) \times 24}{24\,Q^3}$$

$$= W'_a\,\frac{\text{average of cubes of load curve ordinates}}{\text{cube of average load curve ordinates}}$$

or $W' = W'_a \times Z$, where Z stands for the fraction in the last equation, and W' is measured in H.P. hours per day.



Load Curve.

$$\text{Now } W'_a = 24KQ^3 = 24(712)\,\frac{fLeQ^3}{D^5} = 17100\,\frac{fLeQ^3}{D^5},$$

and if we take N equal to the number of days in a year that the load curve giving a loss equal to W' occurs, etc., for each type of load curve, so that $\Sigma N = 365$, the total number of days per year, we have

$$\text{Yearly loss} = \Sigma(NW') = \Sigma(NW'Z) = \frac{(17100)fLe}{D^5}\Sigma(NQ^3Z)$$

If k equals the sale value of one kw. hour in dollars, then the value of the energy lost

$$= A_1 = \frac{(17100)(0.746)fLek}{D^5}\Sigma(NQ^3Z).$$

The yearly cost of the pipe may be found as follows.

The thickness in inches $= t = \frac{p \times D}{2se_1}$, where p is the intensity of pressure in pounds per sq. in., s is the allowed tension in the same units, e_1 is the efficiency of the joint and D has the same value as used above.

$$\text{Then}\quad t = \frac{(0.434)HD}{2se_1} = 0.217\frac{H}{se_1}D.$$

Let the weight of pipe in pounds per lin. ft. = btD and the total weight will equal btDL.

Substituting for t the value found above we get total weight

$$= 0.217\frac{bHL}{se_1}D^2$$

$$\text{The yearly cost of pipe} = A_2 = 0.217\frac{bHLci}{se_1}D^2$$

The most economical size of pipe is that size for which the sum of the annual value of the energy lost plus the annual cost of the pipe is a minimum.

$$\text{Hence}\quad A = A_1 + A_2 = \text{a minimum.}\qquad \therefore \frac{dA}{dD} = 0.$$

Substituting for A_1 and A_2 we have

$$A = (12750)fLek\,\Sigma(NQ^3Z)\frac{1}{D^5} + 0.217\frac{bHLci}{se_1}D^2$$

$$\text{and}\quad \frac{dA}{dD} = -(63750)fLek\,\Sigma(NQ^3Z)\frac{1}{D^6} + 0.434\frac{bHLci}{se_1}D = 0$$

$$\therefore D = \sqrt[7]{\frac{(147000)fese_1k\,\Sigma(NQ^3Z)}{bHci}} \quad \ldots\ldots\ldots\ldots\ldots\ (1)$$

From this value of D, the thickness t may be found as

$$t = 0.217\frac{HD}{se_1}.$$

Suppose now, that the thickness of the pipe is fixed and the problem is to find the most economic diameter. This might be the case where the pipe line closely follows the hydraulic gradient for a distance before dropping down to the power house.

The total weight of pipe = btLD since btD = weight per foot.

$$\text{Then}\quad A_2 = btLciD.$$

$$\text{As before } A_1 = (12750)fLek\,\Sigma(NQ^3Z)\frac{1}{D^5}$$

$$\therefore\ A = A_1 + A_2 = (12750)fLek\,\Sigma(NQ^3Z)\frac{1}{D^5} + btLciD$$

$$\frac{dA}{dD} = -(63750)fLek\,\Sigma(NQ^3Z)\frac{1}{D^6} + btLci = 0$$

$$\text{Hence}\quad D = \sqrt[6]{\frac{(63750)fek\,\Sigma(NQ^3Z)}{btci}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ (2)$$

It may be seen from equation (1) that under low heads, the value of D may be such that the resulting thickness of pipe will be too small for practical use. If this be the case, the minimum value of t (depending on the problem) should be substituted in equation (2) and D found from that equation. It will also be noticed (equation 1) that D decreases as H increases. Hence, if the head on the pipe varies along the length to a great extent, there may be economy in using several diameters, decreasing as the head increases.

Method of Tapping Large Steel Mains Under Pressure

Both the operating mechanism and method for cutting cast iron mains and steel mains are similar but the latter work involves certain features not present in making connections to cast iron mains. Some useful suggestions on tapping steel mains were given by Mr. D. F. O'Brien, president and manager, the A. P. Smith Mfg. Co., East Orange, N. J., in a paper presented at the last annual convention of the American Waterworks Association, from which the matter following is taken:

Steel mains, whether made by the alternate inside and outside courses, or put together by telescopic taper joints, are never truly cylindrical. Measurements taken only a few feet apart on the same section of pipe will frequently show marked differences in contour. This fact occasions the principal difficulty in making connections to steel mains, as the lead joint between the tapping sleeve and the pipe cannot be satisfactorily calked unless the joint is approximately uniform and of the correct thickness. To secure that condition it is necessary to get the dimension of the pipe where the sleeve encircles it at both ends, also the dimension from the vertical axis around to the horizontal seam, the width of the seam, the height of the rivet head and the contour of the pipe at these several points.

The contour of the pipe may be determined by encircling it with a flat ring whose diameter is larger than the largest axis of the pipe. This ring is adjusted on the pipe by thumb screws placed on the horizontal and vertical axis. The distance from the inner edge of the ring to the pipe is noted at intervals of 30 degrees around the periphery. From those dimensions the contour may be determined with enough exactness for practical purposes. The pattern for the sleeves is made to conform to the dimensions and contour of the pipe, due allowance being made for the desired thickness of joint. A cylindrical sleeve made to the nearest dimensions to suit the pipe would result in the sleeve and main being metal to metal at some point, while at others there would be 1½ to 2 in. of lead, which could not be satisfactorily calked. For this reason we must be certain that, with the correct pattern, care is exercised in the foundry in the molding and cooling of the casting to see that it is in accordance with the pattern. If care is not taken, deformation will result, necessitating scrapping the casting or causing trouble in doing the work.

The sleeve casting, being tested and found correct to dimensions and contour, is adjusted on the pipe in the same manner as in doing the work on cast iron mains. In pouring and calking the joint, however, greater care must be exercised, as the sheet steel presents a comparatively smooth surface and the lead will not form as close frictional contact with it as it does with the rough surface of cast iron pipe. For that reason it is advisable to pour the lead as hot as possible. The calking should be done only by one who has had experience in working on steel mains as the lead must be thoroughly upset and driven hard, but in doing so the pipe must not be deflected.

In operating the cutting mechanism in both the drilling and cutting operations, particular attention must be given to keep a light continuous feed. If the feed is interrupted the cuttings will be ground between the cutters and the pipe, thus destroying the cutting edge which makes necessary the removal of the cutter for resharpening—something that should be avoided. On the other hand, if the feed be heavy or erratic, the pipe is so flexible that it is easily deflected and the lead joint broken or worse still, one of the teeth of the cutter may be broken which means the removal of the cutter.

These several obstacles may be readily overcome by absolute attention to the several details, taking care that this work is entrusted to men who have had experience in this particular line.

New Irrigation Laboratory for California.—The Division of Irrigation Practice of the University of California is installing a complete field laboratory at Davis which will be used for instructional and demonstrational purposes. This will include all types of equipment used in orchard and alfalfa irrigation, both from open ditches and concrete pipe line.

Special Features of Recent Filter Plant Design

Small Plants Designed for Economy of Construction and Operation, Described in Paper Presented at Meeting of Illinois Section, American Water Works Association, March 29, 1922

By PAUL HANSEN

Of Pearse, Greeley and Hansen, Engineers, Chicago, Ill.

Since rapid sand filtration has become accepted as an economical and efficient method of water purification there has developed a tendency toward over-standardization. That is to say, too many of the details are regarded as definitely settled and perfected; and engineers and filter companies are not always as alert as they should be to possible improvements or to the adjustment of design to the particular water to be handled or to the particular place where the plant is to be built.

Improvements are as a matter of fact being made and these should have due recognition, but there is lacking the same eagerness that was apparent about fifteen to twenty years ago. Perhaps the discouragement lies in the fact that with the present development of rapid sand filtration further improvement must be looked for in the refinement of details rather than in changes of a striking or radical nature, and this in turn may make lack of progress more apparent than real.

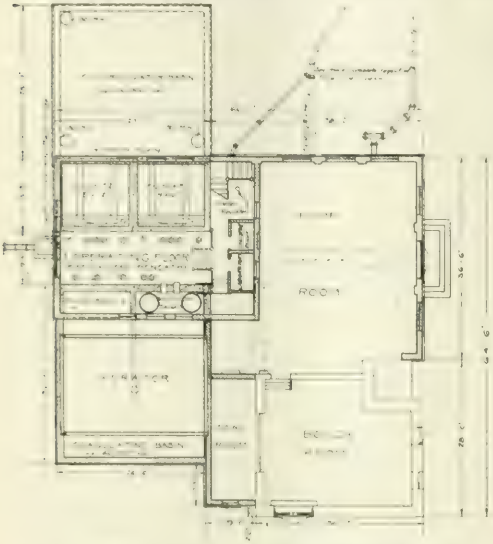


Fig. 1.—General Plan of Plant at Harrodsburg, Kentucky.

The object of this paper is to stimulate a little thought along the lines of filter design improvement by describing a few efforts in recent experience, principally our own, and perhaps to throw out a few suggestions.

In our recent designs of relatively small filter plants ranging in size from one-half million gallons per day to 4,000,000 gallons per day, we have kept in mind especially the securing of operating economies. In all of these cases we have so coordinated the design with the pumping station as to enable the pump attendants to operate the filters.

One Man Operated Plant. In the case of a small plant at Harrodsburg, Kentucky (Fig. 1), it will be possible for one man per shift to operate the entire waterworks. This is made possible by the installation of an electric equipment which will carry the ordinary load. The old steam pumping equipment will be retained as a standby. Should it be necessary at any time to operate the steam pumping equipment for any length of time it may be necessary to hire extra labor for firing the boiler.

At Whiting, Indiana and Winnetka, Illinois, the pumping equipment has been made accessible to the filter plant so that on the night shift it will not be necessary to have a special filter attendant. However, these plants are of sufficient size to warrant the employment of one filter attendant on each of the two day-time shifts. In the Winnetka plant a small tunnel was built to give free access between the filter plant and the pumping station. This tunnel also has the additional merit of providing a gallery for water and steam pipes and electric conduits in a manner to give them free accessibility.

Saving in Pipe Without Crowding.—Economy effected in our recent designs for small plants is obtained through the relative arrangement of reaction chamber, sedimentation basins and filters. In a 600,000 gallon per day plant like that at Harrodsburg and a 3,000,000 gallon per day plant like that at Winnetka it is feasible to place the coagulating basins opposite the filters in such manner that all of the piping for the entire filter plant may be placed within a single pipe gallery. This very materially reduces the tonnage of cast iron pipe required. It is difficult to express the exact saving made in this way, but in round numbers the arrangement effects a saving of about 10 per cent on tonnage of cast iron pipe as compared to several less compact layouts originally considered. Not only has this arrangement the merit of economy, but it very greatly simplifies operation inasmuch as the filter operator must take but a very few steps to reach any controlling valve in the entire plant. The arrangement also brings one end of the coagulating basins and the reaction chamber within the filter superstructure so that the operator may with the greatest possible ease observe the effect of coagulation. A further economy in this arrangement is the reduction of the size of superstructure required for the plant.

The pipe galleries have been designed so as to give a free passage from end to end with ample head room as shown in Figures 2 and 3. This is of very great value in giving access to the numerous pipes and valves used in connection with the filters and sedimentation basins, and also in giving access to the filter rate controllers for making repairs and adjustments. The value and economy of a clear pipe gallery can only be fully appreciated by those who know the difficulty of taking out a pipe, repacking or repairing a valve, or taking apart a rate controller in a crowded pipe gallery of the old type.

The free passage through the pipe gallery not only represents economy through giving greater accessibility to the complex piping but actually represents a saving in pipe. This has been accomplished largely through the use of a single four-way specially designed casting at the lower filter opening. This incidentally is the only specially designed casting in the whole pipe gallery. All the other specials are standard.

Lighting and Its Importance.—There can be little argument as to the advantage of light in filter plants. Yet as a matter of fact this has often been neglected in most designs so that many parts of the plant—more particularly the pipe gallery—have been dependent upon artificial light. Moreover, the crowded condition of pipe galleries and other parts due to a multiplicity of piping has prevented a proper dissemination of light. In the designs for recent plants, special consideration has been given to the matter of having a flood of light in all parts of the plant that should be readily accessible for inspection and repairs—more particularly the pipe gallery and filters. Economy of light is difficult to estimate in dollars and cents, but there can be little room for doubt that laborers working on piping and valves and dependent upon imperfect artificial light are seriously handicapped and inevitably work more slowly. A measurable portion of their time is taken up in adjusting and shifting extension lamps so as to get a clear view of their work. The most serious objection to lack of light, however, is that the dark places are invariably neglected. Leaks and breakages go unattended and cleanliness is generally ignored.

Chemical Handling.—It is important to give careful consideration to the arrangement of chemical preparation and feed devices. The main consideration is to have them so readily accessible that the attendant will have no excuse for neglecting their proper operation. In the larger plants we

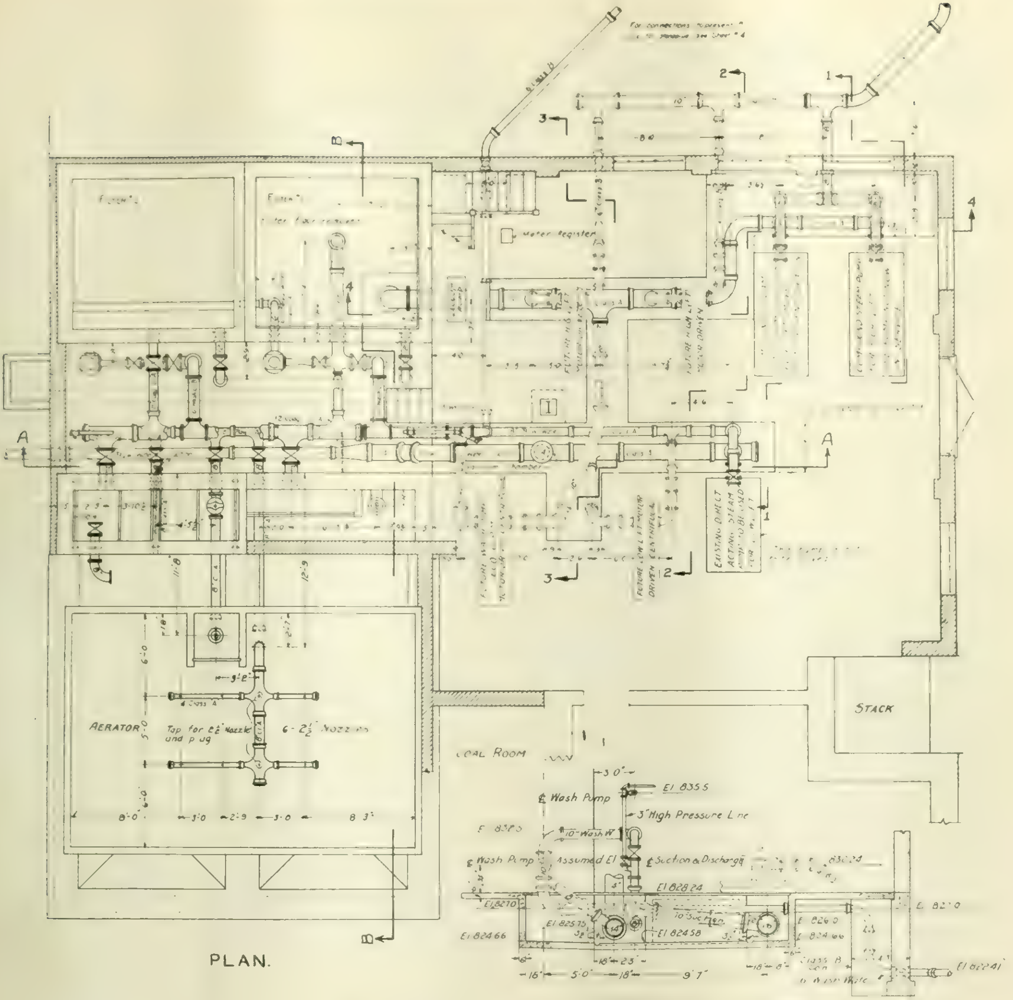


Fig. 2.—Piping Plan of Harrodsburg Plant.

have found it desirable to arrange for the preparation of chemicals on a second floor and also provide space at this point for the storage of chemicals. This is typical of the Winnetka plant and the Whiting plant. This arrangement greatly facilitates the labor involved in dissolving and mixing the chemicals or discharging the chemicals into a dry feed machine, notwithstanding the fact that this places some of the operations on another floor. In the very small plants, however, like that at Harrodsburg, it has been found practicable to place the entire chemical preparation and feed devices within the operating room. In all cases, to facilitate the hoisting of chemicals, some form of elevator is used. In the case of Whiting and Winnetka, the elevator can carry both freight and passengers. In Harrodsburg, however, a small lift will be used which will consist either of some form of block and tackle arrangement or a form of dumb waiter. In all of the plants it is easily possible for the filter operator to handle the chemical feed devices; though during periods when consignments of chemicals are received, one or two laborers will be required to help place the chemicals in the storage space.

In all cases the chlorine apparatus and the laboratory are placed in close proximity to all of the filter operations. At Whiting and Harrodsburg they are on the same floor and within but a step or two of the operating devices. At Winnetka, however, it was found necessary to place the laboratory on the second floor adjoining the storage space for chemicals. While not ideal, this arrangement is not believed to involve any material disadvantages.

Valve Operation.—In the Whiting and Winnetka plants the filters have been equipped with hydraulically operated valves inasmuch as this is warranted where four or more filters are used and on account of the larger size of the valves. Hand operation would take considerable time and considerable effort. In the small plants, however, like that at Harrodsburg with only two filter units of small size, hand operation is entirely practicable and, of course, represents an economy in first cost.

Summary.—In the foregoing we have discussed primarily those matters which have a relation to economies in operating attendance, maintenance, upkeep and fixed charges. It is important, however, to remember that the sedimentation basins must be designed with careful regard to the character of the water to reduce to a minimum the amount of chemical treatment required.

The cost of chemicals is a very considerable item in filter operation, generally amounting to something like 30 per cent of the total operating costs at a small installation and

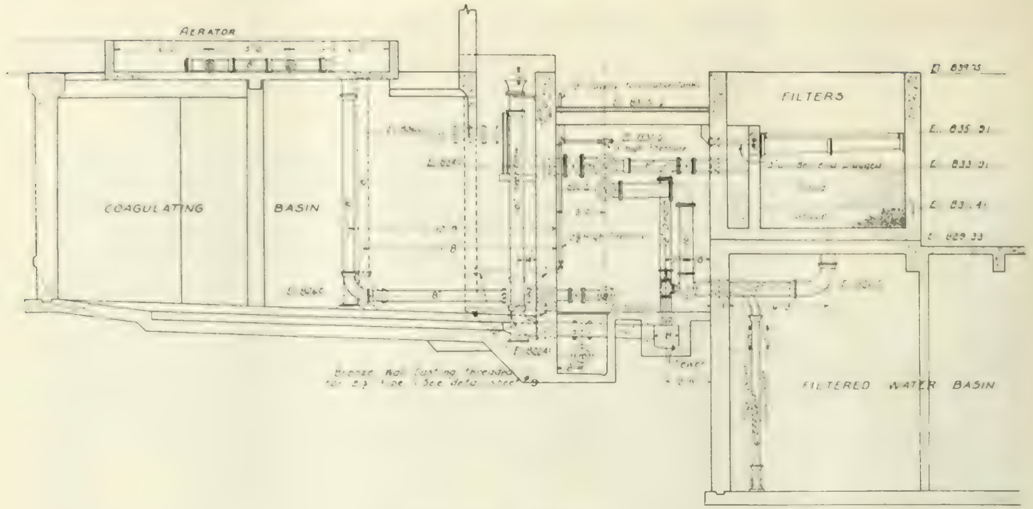


Fig. 3—Section B-B of Fig. 2.

perhaps much more than this in the case of larger plants. It may often pay to install larger sedimentation basins, even though this involves an increase in the first cost, provided it can be demonstrated that the reduction in operating costs will represent a net reduction in total annual costs. It is significant that the modern tendency is toward larger sedimentation basins. Another possibility for saving alum is the selection of a proper size of sand. A relatively fine sand with certain types of water may permit a material reduction of alum and effect net economies even with shorter filter runs and more wash water.

At Sacramento, studies indicated an economy of stirring devices in reaction chambers as compared with baffles; and they also showed it feasible to use larger and fewer pipes in the underdrain system than is ordinarily done in practice.

There is also an opportunity to effect real economies on total annual costs by providing a proper storage of filtered water. If sufficient storage is not provided it means that the filters must be operated beyond their normal capacity which will require additional quantities of coagulant and larger quantities of wash water for the filters. More serious, however, is the danger of delivering an imperfectly filtered and sterilized water when the filters are operated very materially above their normal capacity.

Recent Developments in Aerial Wire Ropeways

From Times Engineering Supplement, London.

Some recent applications of aerial wire ropeways were described by Mr. J. Walwyn White in a paper read before the Liverpool Engineering Society.

He pointed out that there are two main types of ropeways. In the first and earlier type, one rope only is employed for the dual purpose of sustaining the weight of the load, and for transporting it along from one end of the line to the other. This rope is spliced into an endless loop, one end of which passes round the driving pulley at the driving terminal, and the other end round a tension pulley at the return terminal. The rope is sustained at intervals of about 100 yd. by supporting sheaves mounted on standards of wood, or steel, and latterly occasionally of reinforced concrete. This simple type is very efficient where the line is straight from end to end, the gradients easy, and the individual loads relatively small.

In the second and more elaborate type, two ropes, or rather three ropes are used. Two of these ropes are fixed, and stretch from one end of the line or section to the other, one end of each rope being usually anchored down, while the other end passes over a balance weight to keep the rope up to its work and to compensate for the varying length of rope, owing to stretch and variations in the temperature. The loads are suspended from this rope by means of a couple of carrier wheels though in the case of heavy loads of about four tons and upwards four carrier wheels are usually employed. These loads are traversed from one end of the line to the other and back again by means of a third rope called the haulage rope. This rope, like the one rope in the first type, is spliced endless in situ, and passes around the driving pulley at one end, and around the return or tension wheel at the other terminal. The fixed carrying ropes are supported at intervals of 100 and 200 yd. or so by rope-bearing saddles mounted on standards as in the first type. The standards are also provided with running sheaves or rollers for supporting the haulage rope, which is constantly running when the ropeway is at work. The supporting ropes being fixed, they can be as stiff and as heavy as may be desired, and consequently can be made with a very high factor of safety.

The carrying sheaves are usually provided with ball or roller bearings, thus giving a very low coefficient of tractive effort, but as these bearings are rather expensive, a cheaper type of bearing has recently been introduced which has produced excellent results. In this form part of the bearing surface of the bushing is actually cut away, so as to form a series of inclined planes round the inside of the bearing, and running through the whole length of bearing except for a short length of close fitting collar at each end, which is provided to keep out the dust and to retain the lubricant. These inclined planes are made double, that is, facing in each direction of revolution, so that they will function in whichever direction the wheel is running, and there are usually five series of them in a bearing. All the series are connected together by a groove at each end of the bearing just inside the collar. The grooves are filled with oil or other lubricant, which they supply to the inclined planes; in another form a hole is drilled up the center of the spindle, with one or more transverse holes connecting the main central hole with the outside of the spindle, and thus to the inside of the bearing.

One great advantage enjoyed by the double rope or bi-cable system is the ease with which angles, both vertical and horizontal, can be made absolutely automatically, and another is that the carriers, whether loaded or empty, are returned around, the return, terminal absolutely automatically. In addition, the grippers on modern installation are usually of the automatic gravity type, that is, the weight of the load itself gives the gripping power on the hauling rope, with automatic engagement and disengagement to and from this rope, so that, as a matter of fact, the carriers are never touched by hand from the time they leave the loading rail until they arrive back empty and are automatically detached from the hauling rope and run up to the buffer on the loading rail, where they are brought up and stand ready for their next load.

Stresses in Concrete Drain Tile

By J. A. WISE,
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While considerable work has been done in testing tile and concrete, and in determining the pressures occurring in the trenches, the results of such investigations have not been applied to a rational design for concrete tile. The customary wall thickness used is one-tenth of the internal diameter. For tile up to 20 in. a corrugated outer form is used, but the usual size and number of corrugations is such that their effect need not be considered. Where the corrugations are large and continuous, a correction will be introduced later, but for the first formulae, the tile will be assumed smooth.

The bending moments existing in tile under external pressure have been worked out by Prof. Talbot (Bulletin 22 of the Illinois Experiment Station) and by Marston and Anderson of the Iowa Engineering Experiment Station. The last two have also determined the pressures in trenches and their results will be used later on in this paper. For tile whose top fourth and bottom fourth are imbedded, the bending moment is

$$M = .1000 \frac{W}{12} (d + t)$$

where M is the bending moment in inch pounds, W is the load per linear foot and is equivalent to the ordinary supporting strength of the A. S. T. M. Specifications, d is the diameter in inches, and t is the thickness of wall in inches.

This moment occurs at a and b in Fig. 1. The method of loading shown is known as the sand bearing method for the testing of tile and also approximates the worst loading conditions met with in practice in trenches.

For an unreinforced concrete beam, the tensile stresses reach their ultimate values long before the compressive stresses do, and so, in discussing conditions at failure, a parabolic law of variation for the tensile stress and a linear law for the compressive stress may be assumed. In numerous works on concrete it has been shown that these laws approximate the truth very closely. As our section is uniform in width our curve of stress variation must be continuous, and therefore the curve of tensile stress must be tangent to the line of compressive stress where they meet, i. e., at the neutral surface. Due to this fact, and also because our material acts differently in tension than in compression, the neutral surface will not be at the center of the tile, but will move toward the side that is in compression. We will assume that we are dealing with a straight beam in the vicinity of a and b. While this is not so, for we have a curved beam, yet it can be shown that for the ratio of wall thickness to diameter usually found in tile, the difference is practically inappreciable.

Figure 2 shows a section of the tile at a or b. The shaded portions represent the stresses. The tensile stress is represented by a parabola whose vertex is at A, and referring it to the X and Y axes shown, its equation is

$$y^2 = 4 c x.$$

To determine the value of c we substitute the values of one point on the curve, $y = k t$, $x = f_t$ (f_t is the maximum tensile stress and f_c is the maximum compressive stress).

$$c = \frac{k^2 t^2}{4 f_t}$$

Therefore the equation of tensile stress is,

$$y^2 = \frac{k^2 t^2}{f_t} x \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Since the tensile and the compressive stress curves have a common tangent at the neutral surface,

$$\frac{dy}{dx} = \frac{(1\text{-}k)t}{f_c}$$

$$\frac{kt}{2 f_t} = \frac{(1\text{-}k)t}{f_c}$$

$$\frac{f_t}{f_c} = \frac{k}{2(1\text{-}k)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

The area of a parabola from the origin to (x, y) is 2/3 x y, and equating the total tension to the total compression,

$$\frac{2}{3} f_t\, k\, t = \frac{1}{2} (1\text{-}k)\, t\, f_c$$

$$\frac{f_t}{f_c} = \frac{3(1\text{-}k)}{4k} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

combining (2) and (3),

$$\frac{k}{2(1\text{-}k)} = \frac{3(1\text{-}k)}{4k}$$

$$\frac{k^2}{(1\text{-}k)^2} = \frac{3}{2} \text{ or } \frac{k}{(1\text{-}k)} = \frac{\sqrt{3}}{\sqrt{2}}$$

$$k = \frac{\sqrt{3}}{\sqrt{3} + \sqrt{2}} = \frac{1.732}{3.146} = .551 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

$$\frac{f_t}{f_c} = \frac{.551}{2 \times .449} = .6125 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Equating the bending moments, and taking moments about a point in T (since the centroid of a parabola, $y^2 = 4 c x$, is 3/8 y_1 from the X axis where y_1 is the boundary ordinate; and the centroid of a triangle is 2/3 the distance from a vertex to the opposite side),

$$M = \frac{1}{2} f_c (1\text{-}k)\, t \left| \frac{2}{3} (1\text{-}k)\, t + \frac{5}{8} k\, t \right| = .1 \frac{W}{12} (d + t)$$

$$\frac{1}{2} f_c (1\text{-}k)\, t \left(\frac{2}{3} - \frac{1}{24} k \right) t = \frac{.1}{12} W (d + t)$$

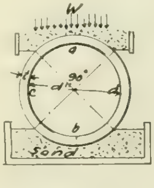

Fig. 1.

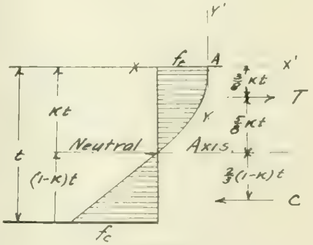

Fig. 2.

$$f_c = .0577 \frac{W (d + t)}{t^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

$$f_t = .0353 \frac{W (d + t)}{t^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

By means of the above formulae Table I has been computed, the modulus of rupture being

$$.05 \frac{W (d + t)}{t^2}$$

We have thus shown, that for the same quality of concrete, the customary ratio of wall thickness to diameter is not consistent with the A. S. T. M. requirements. We will also show that the A. S. T. M. requirements bear no relation to the load that the tile must carry. It is true that paragraph 36 of the A. S. T. M. Specifications provide for tile of greater strength in deep cuts, but it is an optional paragraph and is not much used. It is also ambiguous in that it does not specify any procedure in the event of the tile cracking in the ditches, nor does it place any time limit upon such an event.

Let us proceed to design one drain tile in a rational manner. We shall assume that the concrete used is all of the same quality. This assumption really favors the large tile as they can be made of coarser mixtures and wetter. As a reasonably attainable figure we shall assume the tensile

TABLE I.

Diam. of tile, in.	Thickness of wall, in.	Ordinary supporting strength (A.S.T.M.), per lin. ft.	Modulus of rupture, per sq. in.	Maximum tensile stress, per sq. in.	Maximum compressive stress, per sq. in.
6	0.6	1,200	1,100	777	1,270
8	0.8	1,200	825	599	952
12	1.2	1,200	550	388	634
18	1.8	1,400	428	302	493
30	3.0	2,000	366	259	422
42	4.2	2,600	341	241	393

strength of the concrete to be 450 lb. per square inch. This is a figure that each tile factory must determine for itself from tests of its product from time to time. The load that the tile will be required to bear will be computed by Marston and Anderson's formula.

$$W = C w B$$

where W is the load per linear foot upon the tile, w is the weight of the ditch filling in pounds per cubic foot, B is the width of the trench at the level of the top of the pipe, and C is a coefficient depending upon the character of the filling material and upon the ratio of depth to width of trench. Let H be the depth of fill to the top of the pipe, then this ratio is H/B. In Bulletin 31 of the Engineering Experiment Station of the Iowa State College of Agriculture the values of C for various soils and conditions of saturation are given. In Table II below these values are partly reproduced for saturated yellow clay, and for saturated sand.

The value of w for saturated yellow clay is 130 and for wet sand is 120. For our present computations, we shall use the values of C for saturated yellow clay as representing the worst possible condition of loading. The wall thickness will tentatively be assumed as 1/10 of the internal diameter, as a first approximation in order to arrive at the width of trench. The trench will be assumed 6 in. wider than the outside diameter of the tile at the level of the top of the tile. For the equivalent of standard quality drain tile we shall assume a depth of trench of 6 ft. above the top of the tile, and for extra quality or double strength tile we shall assume a depth of 12 ft. of filling above the tile. These values are arbitrary and each engineer ought to select such values for every system he designs as are best suited to represent average depth and extra deep cuts. As recommended by Marston and Anderson, a factor of safety of 1.65 will be used. The results are shown in Table III.

The column headed 1.65 W gives us the strength that ought to be required of the drain tile for the depths indicated. As in the A. S. T. M. specifications, no one tile should fall below 25 per cent less than the above value. Except for 6 and 8 in. tile, these values are all higher than the A. S. T. M. requirements, and it is believed that the tabulated values are the ones that should be used in specifications. Intermediate values can be easily computed and the values of C for sand used where such soil is encountered. There is no valid reason for not designing drain tile as one would design any other engineering structure. In each case the engineer should determine the loads to which the tile will probably be subjected and then see that he gets tile that will sustain that load. Each system will have its own problems and no rigid rule can be laid down. A good plan is to divide the tile into two, three or even four classes according to depth and specify the strength required for each class, leaving the manufacturer to work out the method of securing that strength. The column headed "Wall thickness for f_t = 450 lb." is merely for comparison purposes, this value of f_t being an average value taken from a large number of tile tests, the maximum value being 825 lb. For standard drain tile, it shows that for the average factory, the wall thickness used now is just about correct. For greater strengths, the quality of the concrete can be improved by using coarser gravel and better graded, by using wetter mixtures and by better curing; or the thickness may be increased; or the tile may be reinforced. Where tile have a continuous corrugation on the outside, the thickness may be considered as the average of the thickest and thinest portion; but this rule should not be used ordinarily, where the corrugations are small and few.

TABLE II.

H/B	1	2	3	4	5	6	7	8	9	10
C for saturated yellow clay	[illegible]	1.62	2.19	[illegible]	[illegible]	[illegible].32	3.55	3.74	3.89	4.01
C for saturated sand	[illegible]	1.47	1.90	2.22	[illegible]	[illegible]	[illegible]	2.82	2.88	2.92

TABLE III.

Internal diam. of tile, in.	Width of trench, ft. B	H/B	C	W	1.65 W	Wall thickness for ft. = 450 lb. in.
(For standard drain tile, H = 6 ft.)						
[illegible]	[illegible]	[illegible]	2.18	[illegible]	925	[illegible]
[illegible]	[illegible]	4.6	2.87	[illegible]	1,040	[illegible]
[illegible]	[illegible]	[illegible]	2.42	915	1,510	1.25
[illegible]	[illegible]	2.6	1.94	1,335	2,200	1.85
[illegible]	[illegible]	1.7	1.74	[illegible]	2,520	2.06
[illegible]	4	1.3	1.00	[illegible]	4,750	4.15
(For double strength drain tile, H = 12 ft.)						
[illegible]	[illegible]	10.9	4.10	[illegible]	[illegible]	0.75
[illegible]	[illegible]	9.2	[illegible]	[illegible]	[illegible]	1.00
[illegible]	[illegible]	7.1	3.57	[illegible]	2,210	1.41
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	2.43	[illegible]	6,350	4.13
[illegible]	[illegible]	[illegible]	1.94	[illegible]	9,220	[illegible]

Some Facts About "Residual Alum" in Filtered Water*

By A. M. BUSWELL AND G. P. EDWARDS
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Various material (References 1-13 inclusive following) is available in the literature of the subject which indicates certain wide limits within which aluminum will be more or less completely precipitated, and beyond which it will be partially or completely dissolved. The work of Hildebrand (1) long ago indicated the importance of using the hydrogen electrode for the investigation of certain types of chemical reactions. Later Blum (2) applied this method to the study of the determination of aluminum in quantitative analysis. He showed that if the pH were adjusted to from 6.5 to 7.5 and the reaction mixture then boiled, he obtained complete precipitation i.e. less than 0.1 mg. in 100cc. of the original solution. Since NH_4OH was used as the alkali, heating must have affected the final pH. Altogether it is evident that Blum's conclusions do not necessarily apply to the precipitation of $Al(OH)_3$ in small quantities in the cold.

Investigation by Illinois State Water Survey.—In September, 1920, this laboratory undertook an investigation of the various reactions involved in water purification, using the hydrogen electrode as the principal means of carrying out the investigation. The results (3) of this investigation showed among other things that pH determinations alone were not sufficient for determining the optimum conditions for precipitation of aluminum hydroxide. A different laboratory method of attacking this problem was therefore decided upon.

Since the laboratory procedure chosen was one which involved considerable labor it seemed advisable to make a field survey of various filter plants in the state in order to estimate the possible practical value of more exact information concerning the condition for the precipitation of $Al(OH)_3$. It is this field survey which constitutes the subject of the present paper.

Since the completion of the first stage of the investigation two articles have appeared by Wolman (14, 15) and Hannan which furnish a very complete review of the current scientific literature having a bearing on the alum precipitation question. These authors in their experimental part confirmed the statements of Blum, Mahin and others to the effect that aluminum hydroxide is appreciably soluble at a pH of 8 or more, probably existing as the acid ion. They further showed that by acidifying their reaction-mixtures as Blum did to a pH of about 7, a more complete precipitation was effected. Pirnie (16) has discussed the colloid chemistry of water purification and the relation between alkalinity and coagulation and Eddy (17) has presented the possible applications of the pH determinations to filter plant control.

The data described in this paper was collected by visiting over twenty filter plants in different parts of Illinois. Due to irregularities in operation at the time of the visit some of the results had to be discarded. The data on twenty-one plants are given. The determination of alkalinity, free CO_2, and pH were made in the field, while at the same time samples were collected and shipped to the laboratory for the determination of aluminum and iron.

Experimental Methods.—The determinations of alkalinity and free carbon dioxide were made according to standard methods. Hydrogen ion concentrations were determined with the use of Clark's indicators and buffer solutions. The analysis of aluminum, iron and phosphorous was made on the residue from a two liter sample which was taken up in hydrochloric acid, separated from silica by filtration and precipitated with NH_4OH according to Blum's (2) method. The ignited precipitate was Al_2O_3, Fe_2O_3 and P_2O_5. Iron was determined colorimetrically according to U. S. P. H. Standard Methods of Water Analysis (18) and phosphorous was estimated colorimetrically by a method given by Deniges (19) which is briefly as follows: If an acid solution of $SnCl_2$ and an acid solution of $(NH_4)_2MoO_4$ is added to water containing small amounts of phosphorous, a blue color is produced, the intensity of which varies with the amount of phosphate present. These colors may be compared with standard phosphate solution.

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*Paper presented at meeting of Illinois Section, American Water Works Association, March 30, 1922.

Aluminum was calculated from the difference between iron and phosphorous and the aluminum, iron, and phosphorous.

Reference to such authorities as Aberhalden (20), Richter (21) and Prideaux (22) indicates that haematoxylin is in an indicator changing color with the pH. Hence, its use in the aluminum determination would only be possible in a buffered solution. This is accomplished in a measure by blowing breath (CO_2) into the solution or acidifying with acetic acid as recommended by Richards (23). In addition haematoxylin gives various colors with most of the heavy metals. Morison (24) states that "using pure haematoxylin a red color was given by the raw water and by a water completely clarified by a dose of alum just sufficient"; and Wolman and Hannan (14) state that treated water "showed the usual alumina blue changing to brown with acetic acid." Richards states, however, that the test may be made only in an acid solution in order to avoid the color produced by the alkaline earth. In view of these considerations the "logwood" or haematoxylin test was not used.

Treatment Changes in Alkalinity and pH.—The chemical reactions taking place during coagulation have from time to time been represented in textbooks and technical articles by various styles of chemical equations. All of these show in the main that 8 mgs/1 of alkalinity will react with 1gr/gal. of filter alum forming $A1(OH)_3$. Now as is very well known, none of these reactions go to completion but we have instead a number of reversible reactions each of which depends for its final equilibrium upon all the others. Such complex systems seem to be best represented graphically by the method used by Smith (25) as shown in figure 1.

The heavy arrows indicate the direction of the predominating reaction. The substances toward which the light arrows point will be present in relatively small amounts. It should be recalled in this connection that any secondary reaction which tends to remove a product of a primary reaction will increase the amount of the primary reaction in the direction of the formation of the removed product. Numerical coefficients such as are used in "balancing" ordinary chemical equations have been omitted to avoid complicating the diagram. This formulation shows the interdependence of these reactions. It also emphasizes that in each of these equilibria the hydrogen ion plays a part either directly or through its reciprocal relation to the hydroxyl ion. The relation between alum and alkalinity is shown here as in other representations but it also appears that the loss of CO_2 with the precipitation of $CaCO_3$ may cause a decrease in the alkalinity; and that the addition of lime may cause a net decrease in the alkalinity due to this same precipitation of $CaCO_3$. On the other hand, the formation of colloidal alumina instead of the precipitate would tend to offset the decrease in alkalinity.

An inspection of Table I shows examples of all three of the above mentioned cases. At four out of nineteen of the plants studied (2, 10, 13 and 14) the decrease in alkalinity was greater than the calculated. This group includes as would be expected the three plants at which lime as well as alum was added. At six plants the decrease was less than the calculated.

In addition to those already mentioned we submit the following list of factors which would tend in a measure at least to produce the deviations cited above. Decrease in alkalinity would be caused by: Removal of colloidal iron and aluminum hydroxide and carbonates; removal of alkline turbidity; titration error caused by adsorption acid on colloids during titration (Pirnie) (16); excessively acid alum. Factors tending to offset the decrease in alkalinity are: Use of basic alum; precipitation of basic aluminum sulfate instead of aluminum hydroxide; resolution of $CaCO_3$ previously deposited on the sand.

TABLE I—ALKALINITY AND pH CHANGES IN FILTRATION

Town.	Alkalinity Raw.	Alkalinity Filtered.	Decrease Found.	Decrease Calculated.	pH Raw.	pH Filtered.
1	56	62	—6	—12	7.8	8.1
2	116	110	6	5.6	8.3	7.7
3	178	170	8	11.2	8.3	7.5
4	192	186	6	8.0	8.0	7.5
5	180	176	4	8.8	7.6	7.5
6	79	84	—5	2.96	7.5	7.5
7	134	116	18	14 80	8.0	7.4
8	...	124	...	.....	...	...
9	126	112	14	—1.4	7.9	7.3
10	130	108	22	22.4	7.9	7.3
11	160	154	6	21.6	7.3	7.2
12	68	58	10	7.2	7.5	7.1
13	82	71	11	12.0	8.1	7.0
14	58	54	4	3.68	7.5	6.9
15	132	94	38	24	7.9	6.8
16	48	42	6	16	7.2	6.8
17	54	24	30	16	8.4	6.2
18	46	24	22	12.0	8.5	6.2
19	60	16	44	0.8	7.2	6.1
20	24	2	22	16.8	6.8	6.0
21	...	6	...	.....	...	...

Residual Alum.—Reference is made by Wolman and Hannan (14), Pirnie (16), Eddy (17) and others to "Residual Alum" in filtered waters without any statement as to the comparative amounts in the raw and filtered water nor any indication as to what may be a safe limit for this residual alum. The incrustation of sand and distribution mains and the possible absorption of bacteria (Pirnie) (16) thereby protecting them from subsequent chlorination seem to be the chief objections to "residual alum." Unprecipitated alum has presumably done no work, and the inference is that residual alum is an indicator of faulty operation and poor clarification.

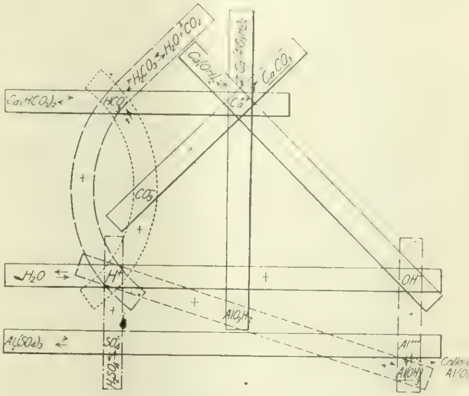

Fig. 1.

Table I furnishes a notion of the extent to which alumina is present in the effluent of some twenty-one filter plants in Illinois. In addition to the description of methods given above it should be stated that in all cases except No. 2 the raw water was filtered through Whatman No. 50 filter paper before making the aluminum determinations. Since a comparison of the aluminum in solution or in a fine colloidal state in the raw and treated waters was to be made, it seemed best to exclude the filterable turbidity. The data on No. 2 indicates what the results might have been without the adoption of this procedure. Nos. 12 and 17 are excluded from consideration since they showed a turbidity in the filtered water of 30 and 25 respectively. Column two shows that in only the two abnormal cases, Nos. 12 and 17, does the alumina in the filter plant effluent exceed 2.15 mg/1 (approximately ⅛ of a grain per gallon); and further that in 13 out of 19 cases, the aluminum is distinctly less in the effluent than in the raw water after filtering through filter paper. It should also be noted that although a fairly wide range in pH value is exhibited by these waters, in no case does the alumina in the effluent reach zero. From our knowledge of the individual plants and their operators we do not feel that this result can be laid to faulty operation.

From the above data it appears that with reasonably good operation the amounts of "residual alum" occurring in filter plant effluent in Illinois are not such as to be cause for alarm. Whether or not the condition of the "residual alum" is such that it is more subject to subsequent deposition or adsorption is a question of further study.

Relation of pH to "Residual Alum."—In the diagrammatic representation of the chemical reactions given above it will be observed that the substances H+, $A1O_3H_2$, $A1(OH)_3$, A1+++ and OH — form a cycle. The reactions may be made to take place in either direction around this cycle depending upon the concentrations employed. Suppose starting with the substances in the cycle in equilibrium, we take away hydrogen ions; more water will be ionized by the reaction from H_2O in the direction of the light arrow. But this will increase the amount of OH— present thereby causing the reaction to go in the direction of $Al(OH)_3$ and removing some of the Al+++ from the solution. If the hydrogen ion concentration is depressed low enough, reaction will take place counter clockwise in the direction of the light arrow from $Al(OH)_3$ to an appreciable extent forming some aluminate ion with the side reaction forming some Ca(AlO H)2. (The aluminate is written in the hydrated form.) If now the hydrogen ion concentration is increased, the reactions will as $Al(OH)_3$ be turned in a clockwise direction, aluminum will be reprecipitated and later dissolved as Al+++. The exact hydrogen ion concentration at which the maximum amount of $Al(OH)_3$ is precipitated has not yet been determined. We believe, however, that we are approaching it by slow degrees.

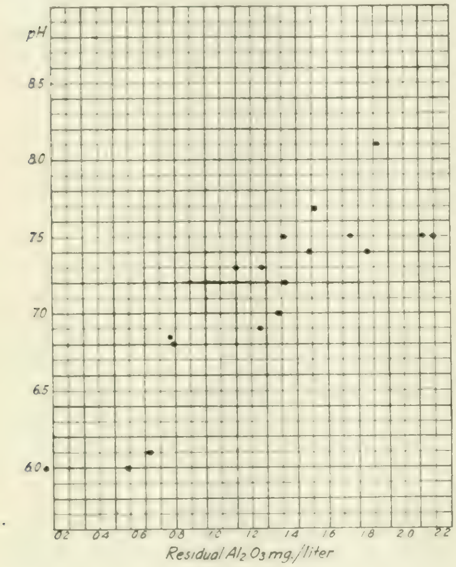

Fig. 2.

Table III presents a summary of the data collected, the filter plants being arranged in the decreasing order of the effluent pH valves. From column three it is seen that with exceptions of Nos. 12 and 17 they also fall in the decreasing order of the residual-alum values. To illustrate this point more clearly, the residual alum and pH values are shown plotted as co-ordinates of points on the accompanying diagram, Fig. II. Though the points do not lie on a smooth curve they show a distinct trend toward a minimum of Al_2O_3 at a pH of about 6. This is much more acid than nay value heretofore reported. It is, however, the first value to be determined under operating conditions and with a gravimetric estimation of the Al_2O_3.

Summary.

1. The chemistry of the alum coagulation process is represented by a diagram which emphasized both the interdependence of the various equilibria involved, and the importance of the hydrogen ion.

2. Data on the alkalinity changes during treatment does not check with expected changes as ordinarily calculated. Various reasons for these discrepancies are discussed.

3. Data presented indicates in general less dissolved alumina in the effluent than in the influent. The amount of alumina in the effluents did not in general exceed 2 mg liter.

4. Points plotted with "residual alum" and pH values as co-ordinated indicate a minimum alumina at a pH of 6, which was the lowest value reached in this series.

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TABLE II.—R_2O_3 IN RAW AND FILTERED WATER (Mg./l.).

	Al_2O_3			Fe_2O_3		
Town	Raw	Filtered.	Decrease.	Raw	Filtered	Decrease.
1	1.36	1.86	—.50	.14	0.14	0.00
2	20.56	1.5	19.06	.00	0.0	0.00
3	3.19	2.15	1.04	.14	0.0	0.14
4	1.81	2.1	—.29	.14	0.0	0.14
5	1.36	1.72	—.36	.14	0.28	—.14
6	1.75	1.39	.36	.00	1.96	—1.96
7	1.21	1.51	—.30	.14	0.14	0.00
8		1.86	..	.	...	....
9	2.23	1.25	.98	.00	0.00	0.00
10	1.56	1.12	.44	.14	0.28	—.14
11	2.95	1.38	1.57	.00	0.42	—.42
12	0.97	12.1	—11.13	.28	0.00	0.28
13	1.6	1.35	0.25	.00	.00	0.00
14	0.76	1.26	—.50	.14	0.14	0.00
15	0.82	0.71	0.11	.28	0.14	0.14
16	2.30	0.71	1.59	.85	0.14	0.71
17	0.40	3.16	—2.76	.28	0.994	—.714
18	0.71	0.17	0.54	.14	0.28	—.14
19	3.22	0.66	2.56	1.43	0.14	1.29
20	0.15	0.55	—.40	1.68	0.71	0.97
21	.	0.16			...	....

TABLE III.—SUMMARY OF DATA COLLECTED.

FILTERED WATER								RAW WATER							
						Alkalinity		Pre-treatment						Alkalinity	
Town	Type	Fe_2O_3	Al_2O_3	pH	CO_2	M.O.	Ph'th.	Chemicals. Gr./gal.	Time.	Fe_2O_3.	Al_2O_3	pH	CO_2	M.O.	Ph'th.
[illegible]	[illegible]	0.14	1.86	[illegible]	[illegible]	[illegible]	2	0.75 alum	1 hour	0.14	1.36	7.8	2.0	56	0.0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	116	0	0.75 alum	1 hour	0.00	20.56	8.3	0.0	116	5.0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	1.4 alum	3½ hours	0.14	3.19	8.3	0.0	178	16.0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	1.0 alum	3 hours	0.14	1.81	8.0	2.0	192	0.0
[illegible]	[illegible]	[illegible]	1.72	[illegible]	[illegible]	[illegible]	0	1.1 alum	¼-½ hour	0.14	[illegible]	7.6	4.8	180	0.0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	84	0	0.37 alum	3 hours	0.00	1.55	7.5	4.4	79	0.0
[illegible]	[illegible]	0.14	1.51	7.4	[illegible]	116	0	1.85 alum	1½-2 hours	0.14	1.21	8.0	2.0	134	0.0
[illegible]	[illegible]	[illegible]	1.86	[illegible]	[illegible]	[illegible]	0	0.7 alum	6 hours				...	..	
[illegible]	[illegible]	[illegible]	1.25	[illegible]	[illegible]	112	0	2.8 alum 1.0 lime	4½ hours	0.00	2.23	[illegible]	2.4	126	0.0
[illegible]	[illegible]	[illegible]	1.12	[illegible]	[illegible]	[illegible]	0	2.8 alum	6-24 hours	0.14	1.56	7.9	2.8	130	0.0
[illegible]	[illegible]	[illegible]	1.38	[illegible]	[illegible]	154	0	2.7 alum	4-5 hours	0.00	2.95	7.2	12.0	160	0.0
[illegible]	[illegible]	[illegible]	12.1	[illegible]	[illegible]	[illegible]	0	0.9 alum	4 hours	0.28	0.97	7.5	2.4	68	0.0
[illegible]	[illegible]	[illegible]	1.35	[illegible]	[illegible]	71	0	1.5 alum	½ hour	0.00	1.6	8.1	0.0	82	0.0
[illegible]	[illegible]	0.14	[illegible]	[illegible]	[illegible]	51	0	0.46 alum	None	0.14	0.76	7.5	4.0	58	0.0
[illegible]	[illegible]	0.14	0.71	[illegible]	[illegible]	94	0	3 alum	8-24 hours	0.28	0.82	7.9	3.6	132	0.0
[illegible]	[illegible]	[illegible]	0.71	[illegible]	[illegible]	42	0	2 alum	None	0.85	2.30	7.2	4.0	43	0.0
[illegible]	[illegible]	[illegible]	3.16	[illegible]	[illegible]	4	0	2 alum	3½ hours	0.28	0.40	8.4	0.0	54	0.0
[illegible]	[illegible]	[illegible]	0.17	[illegible]	[illegible]	24	0	1.5 alum	4 hours	0.14	0.71	8.5	0.0	46	5
[illegible]	[illegible]	0.14	0.66	[illegible]	[illegible]	16	0	0.4 alum	3 hours	1.43	3.22	7.2	6.8	60	0.0
[illegible]	[illegible]	0.71	0.55	6.0	[illegible]	2	0	0.5 alum 2.1 alum	5 hours [illegible] hours	1.68	0.15	6.8	6.8	21	0.0
[illegible]	[illegible]	[illegible]	0.16	6.0	[illegible]	6	0	3.5 alum	2 hours	.				..	...

The Bacteria Coli Test

Relation Between Positive Results in Samples of One and Ten Cubic Centimeters

By MILTON F. STEIN,
Civil Engineer, 6753 Lafayette Ave., Chicago

Those concerned with the fermentation test for bact. coli have probably noticed that the percentage positive in a series of ten cc. samples is not ten times that for a series of one cc. samples run simultaneously, and yet that a relationship exists. By making use of the fundamental equations of interpretation* the existing relation can be worked out. For ten cc. samples the relation between average number of bact. coli per sample and per cent positive is:

$$x_{10} = \log (1 - P_{10})$$

and for one cc. samples:

$$x_1 = \log (1 - P_1).$$

Since the average number in ten ccs. is ten times the number per cc. or $x_{10} = 10x_1$.

Substituting the log values:

$$\log (1 - P_{10}) = 10 \log (1 - P_1)$$

or

$$(1 - P_{10}) = (1 - P_1)^{10}$$

wherein P_1 and P_{10} are the percentages positive in one and ten cc. samples respectively. This equation has been plotted on Fig. 1 with P_1 as abscissas and P_{10} as ordinates.

On the same diagram are shown points each representing the percentages of one and ten cc. tests on a filter plant effluent for one month. That is, each point represents from thirty to one hundred actual tests. In all there are 128 points shown. The correlation of these values was worked out on the assumption of the above equation, that is, the logarithm of 1 minus the abscissa was paired off with the logarithm of 1 minus the ordinate for each point. The correlation coefficient so obtained was +.87. Since a correlation coefficient of +1.00 represents perfect agreement between ordinates and abscissas, it will be seen that a close relationship exists on the basis of the above type of equation. The computation of regression, or line of best fit as obtained by the usual method, based on the principle of least squares, is not entirely satisfactory, and is shown by the dashed line. Its equation is:

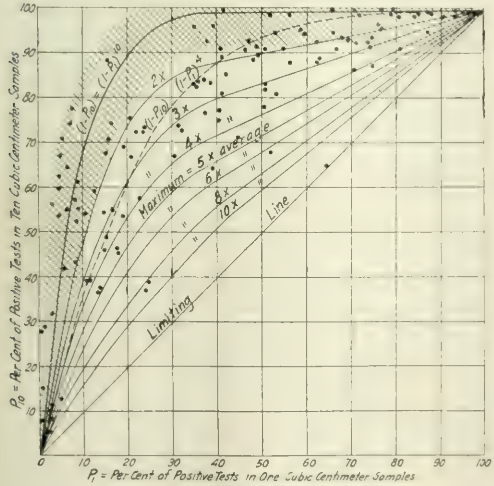

Fig. 1.

$$(1 - P_{10}) = (1 - P_1)^4.$$

The reason why this line and many of the points fall below the theoretical curve is because the latter is derived on the assumption that the number of bact. coli per sample does not vary during the series of tests, whereas the position of the points indicates that there was considerable variation in many cases, even though these tests were made on filter plant effluents.

Besides its general interest, this diagram is of some use in detecting fluctuations in quality of effluent which would pass unnoticed in the usual examination of the monthly percentages. If a point is plotted thereon of which the monthly per cent of one cc.'s positive is taken as abscissa, and the per cent of ten ccs.' positive for the same month as ordinate, then if this point fall in the shaded area, which represents the allowable error for a hundred tests, it may be inferred that the quality of effluent was uniform during the test period. But if the point fall below the shaded area, then the quality fluctuated during the test period, and at times the bact. coli content was higher than the monthly percentage would indicate. Lines have been drawn indicating the ratio of maximum to average bact. coli, from which estimates of the fluctuation may be made. It will be seen that in two of the cases plotted the fluctuation was over ten times the average value, and numerous fluctuations of four times average or more occur. While this aids in the interpretation of the tests, it is not offered as a substitute for a battery method of testing, which makes each sample tell its own story, and which the writer has consistently advocated.

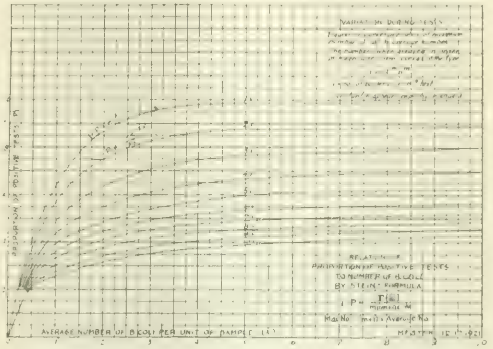

Fig. 2.

Fig. 2 is introduced as an intermediate step to a further relationship between one and ten cc. tests. It shows the relation between the proportion of positive tests and the bacteria, when the latter vary during the series of tests from which the proportion of positive tests is obtained, as is the case when the series extends over a week, month, etc., in the usual manner. It is assumed that when the numbers of bacteria which obtain from test to test are arrayed in order of magnitude that the curve formed is parabolic, and of the general form $x = k^m n^m$, where k and m are constants, and n is the number of the test in the array. The figures on the curves indicate the number of times greater the maximum number of bacteria present during the series is than the average number obtained from the percentage of the series positive. It is evident that for parallel tests of one and ten cc. samples the variation must be the same, that is, they must lie on the same curve. Also, the number of bacteria for the ten cc. tests must be ten times that for the one cc. tests. Therefore, given the percentages positive in two parallel sets of one and ten cc. samples, (1) these must lie on the same curve, and (2) this curve must give a value for the ten cc. tests which is ten times that for the one cc. tests. This value can be found from the diagram by trial, and is the only value fulfilling these conditions. In this way it is possible to obtain from the percentage positive a definite value for the number of bacteria, regardless of how their number may vary during the series of tests, because the use of two sizes of samples fixes the result by giving it a co-ordinate in the third dimension, whereas using only one size of sample leaves the result indeterminate, in that the unknown type of variation may give it different values. The only assumption made is that the type of variation is parabolic, when the ordinates are arranged in the order of their magnitudes. Since the exact form of the parabola does not enter into the question, and since parabolas can be fitted to all manners of curves by proper selection of constant and exponent, this does not seem a very serious restriction. This method is built up on sound mathematical principles and offers a means of interpreting bact. coli percentages with a considerable degree of certainty, always remembering that this test as now conducted is on a very low plane of accuracy.

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*Interpretation of B. Coli Results, Jour. of Bact. IV, 3, May, 1919.

Fig. 3 is handier to use than the method of trials just explained. Having obtained the percentages of one and ten cc. tests positive for, say, a month's tests, enter the diagram from the left with the ten cc. percentage and from the right with the one cc. percentage, following down the diagonals to their intersection and read from the nearest contour the number of bacteria in ten cc. For example, if 80 per cent of the ten cc. and 50 per cent of the one cc. tests are positive, then the intersection of these two diagonals falls on the contour marked 10 B. Coli in ten cc. The diagram can be used just as well for 0.1 and 1.0 cc. tests or 0.01 and 0.1 cc. tests. It is offered in refutation to the following statement in the Standard Methods of the American Public Health Association: "To apply this theory (of probabilities) to a correct mathematical solution of any considerable series of results involves, however, mathematical calculations so complex as to be impracticable of application in general practice."

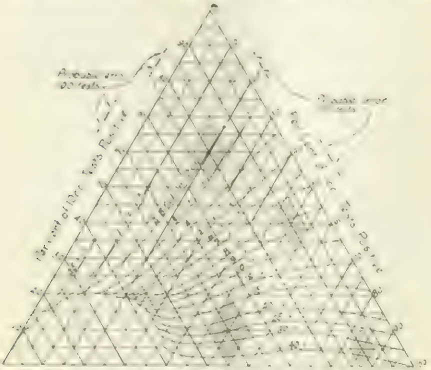

Fig. 3—Diagram for Determination of Number of Bacteria.

The probable error involved in the use of this diagram, when the proportion positive is based on 100 tests, is shown by shaded areas in various parts of the diagram. For thirty tests the dimensions of these areas would be approximately doubled, increasing the areas four times. It will be noted that for some of the higher values the error is very large, which is no fault of the diagram, but is inherent in the fermentation test methods and routine now used.

A similar method might be worked out using 0.1, 1.0 and 10 cc. tests but it is not amenable to graphic representation, and the calculation would probably be too "complex" for general practice, as it would require the use of a log table or slide rule. Another reason against a three value formula is that one of the values would not be of the same degree of accuracy as the other two, being in fact much less reliable. It may be pointed out that the method here described is on an entirely different basis than some which have been proposed, in which the percentages for the several sizes of sample are simply averaged together.

Diesel Engine and Semi-Diesel Engine Precisely Defined

A Diesel engine is a prime mover actuated by the gases resulting from the combustion of a liquid or pulverized fuel injected in a fine state of sub-division into the engine cylinder at or about the conclusion of a compression stroke. The heat generated by the compression to a high temperature of air within the cylinder is the sole means of igniting the charge. The combustion of the charge proceeds at, or approximately at, constant pressure.

A semi-Diesel engine is a prime mover actuated by the gases resulting from the combustion of a hydro-carbon oil. A charge of oil is injected in the form of a spray into a combustion space open to the cylinder of the engine at or about the time of maximum compression in the cylinder. The heat derived from an uncooled portion of the combustion chamber together with the heat generated by the compression of air to a moderate temperature, ignites the charge. The combustion of the charge takes place at, or approximately at, constant volume.—Compressed Air Magazine.

The New Ten Million Gallon, Covered Reservoir at Indianapolis

Design Problems Described and Bidding Prices and Costs Given in Paper Presented Before Indiana Sanitary and Water Supply Association, March 22, 1922

By WILLIAM CURTIS MABEE.

The Indianapolis Water Company built and placed in service in 1921 a ten million gallon reinforced-concrete covered reservoir at a cost of $223,500, complete with pipe connections and appurtenances, but excluding engineering.

The site chosen for the new reservoir was formerly part of the open infiltration gallery at the Riverside Pumping Station, constructed in 1882 and abandoned as a source of supply in 1907, when the first covered reservoir at this station was built.

Limitation of Water Level.—In determining the depth of water to be stored in the new reservoir it was necessary to consider the hydraulic gradient of the supply conduit which discharges filtered water at this station, as affecting the upper limit of elevation of water stored, and a further consideration of the ground water level at this station as the lower limit, keeping in mind the danger of rupture from rising ground water levels. The depth of water stored, ten feet and three inches, was therefore fixed by these two limitations.

It was considered advisable and necessary to so design the reservoir that a rise in the ground water level of ten feet would be counterbalanced by the weight of the structure and the superinforced loading of earth upon the roof of the structure, without consideration of the weight of the water contained within the reservoir.

Arched Floor Design.—This excessive upward pressure of ground water during flood stages calculated to be exerted at a time when the reservoir might be nearly empty, and the necessity of an equal distribution of downward pressure upon the soil presented a problem in the design of the floor which obviously could be best solved by the employment of the groined-arch type of floor construction. It may also be noted that the groined-arch floor forming intersecting valleys can be the more readily flushed when necessary to clean.

While a groined-arch roof would have been as satisfactory as the flat slab type of construction adopted, experience here as elsewhere has shown that contractors as a rule prefer to build along lines with which they are familiar and will for that reason submit lower prices for the flat slab type of construction than for the groined-arch type, notwithstanding the fact that the groined-arch roof requires practically no steel.

Top Weighting.—The necessity of weighting the structure suggested the use of 27 inches of filling on the cover, assumed to weigh when saturated 250 pounds to the square foot. This fill also prevents the formation of ice in the reservoir and tends to maintain the roof slab at a reasonably uniform temperature in all seasons, thereby miminizing the distortion of the structure from temperature changes. The total live and dead load considered upon the roof slab was 470 pounds per square foot, or a superimposed load of 350 pounds per square foot.

Column Spacing.—Having determined the type of structure to be constructed and the loading to be supported, the question of column spacing was next considered. The usual spacing for work of this character varies from 15 to 25 ft. and for the loading under consideration the slab thickness would vary from 7½ in. for the 15-ft. spacing to 12 in. for the 25-ft. spacing; the column spacing could even be made as little as 10 or 12 ft. centers. There is no doubt in the writer's mind that the structure with the smaller column spacing can be built for less money; but considering the ground water problem and the desirability of heavy sections, lending their weight, strength and dependability to the structure in addition to the degree of impermeability required in a structure of this character, the column spacing that would meet these requirements was determined to be 18 ft. centers.

The flat slab is designed in accordance with computations based upon the rulings of the American Concrete Institute for four-way reinforcement.*

Shape, Dimension, and Cost. The reservoir is rectangular with rounded corners—inside dimensions 254 ft. wide, 542 ft. long and 10 ft. 8½ in. deep with a storage capacity of approximately 1 million gallons per foot depth. The net area of water surface is 136,500 square feet or 3⅛ acres, and the cost per million gallons stored, exclusive of piping connections, brick baffle walls and engineering, but including all earth work, was $19,150, which is equivalent to $1.41½ per square foot of water surface.

Expressed in percentage this cost was divided as follows:

	Per cent
Excavation, average cut 11 ft	[illegible]
Refill, 27 in. deep on cover	7.1
Levee embankments	2.0
Concrete structure including sub-grade	[illegible]

The typical labor charges upon which these costs were based were:

Common labor	[illegible] cents per hour
Skilled labor	35 to [illegible] cents per hour
Form builders	60 cents per hour
Teams	[illegible] cents per hour

All levee work was done by force account for which the company allowed the contractor cost plus 15 per cent.

Quantities Involved. Earth work, 80,310 cu. yd., of which 52,175 cubic yards was excavation from reservoir site placed into embankments and spoil banks and 28,135 cu. yd. refill over and around structure and in shaping levees; concrete, 11,158 cu. yd.; cement, 15,523 barrels; steel bars, 464 tons.

Bids Received.—Plans and specifications for the work were prepared and the work divided into two parts: (1) excavation, and (2) concrete work, including refill

Bids were received for the excavation work Feb. 15, 1921, from six local contractors, as follows.

	Per cu. yd.
American Construction Co.	$1.10
Timberlake Construction Co.	0.88
Sheehan Construction Co.	0.90
Mansfield Engineering Co.	0.738
Harold and Bretner	0.90
R. H. Scott & Co.	0.56

The contract was awarded to the R. H. Scott Co. Feb. 26, 1921, the unit price of 56 ct. per cubic yard included all clearing and grubbing of trees and the segregation of the loam, sand and gravel into separate piles, the earth and rejected gravel going into embankments and levees. This work was completed and final payment made Aug. 6, 1921—elapsed time, 5 months, 11 days.

Quantity of material handled, 52,175 cu. yd., including 10,000 cu. yd. of sand and gravel, which was washed and screened from the excavation for concrete work under a supplementary contract. The dimensions of the excavation were 280x570 ft.; area, 3⅝ acres, with a cut varying from zero to 23½ ft., the average being 11½ ft. The character of excavation was top soil and bank gravel. The work contemplated filling an abandoned infiltration gallery or reservoir which extended diagonally across the site for the proposed new structure with sand and gravel from the excavation and rolling the fill with a locomotive crane, the expense of rolling being paid for on force account.

Gravel which was suitable for concrete was washed and screened and stored in piles upon the old infiltration gallery site at an additional cost of 40 ct. per cubic yard.

The top soil was carefully selected and stored in piles conveniently located for top dressing the embankments after the completion of the structure.

Excavation progressed at the following rates: First month, 21 per cent; second month, 42 per cent; third month, 15 per cent; fourth month, 14 per cent; fifth month 8 per cent.

Excavation Equipment.—The equipment consisted of a locomotive crane operating a yard and a half clam bucket, which was used to fill the old gallery and which was also used to elevate gravel to the washing platform. The larger part of the excavation was handled by teams and wheeled scrapers. The average rate of excavation for elapsed time was 324 cu. yd. per day and the maximum rate for 30 days was 750 cu. yd. per day.

Earth refill and embankment was included in the contract for concrete work, and was handled by wheeled scrapers by the R. H. Scott Co. on a sub-contract as follows: 17,985 cu. yd. at 55 ct. per cubic yard; 10,150 cu. yd. by force account estimated to cost 75 ct. per cubic yard.

Total excavation and refill 80,310 cu. yd. at an average cost to the water company of 58 ct. per cubic yard.

The average rate of construction of embankments for elapsed time was 230 cu. yd. per day and the maximum rate for any month was 293 cu. yd. per day.

Concrete Work.—Eleven bids were received for placing 11,158 cu. yd. of concrete, the water company furnishing all cement and steel to the contractor on board cars at water company's switch and also delivering gravel to the site; the contractor unloading, hauling and storing cement and steel, furnishing all material for forms, centers and supports; bending, setting and securing all reinforcing bars, mixing and placing concrete and fine grading, and tamping the bottom of the reservoir. The bids follow:

	Per cu. yd.
Henry Maag	[illegible]
W. F. Jungclaus Co.	[illegible]
Hoffman Construction Co.	11.50
Warner Construction Co.	11.00
J. G. Karstedt	10.00
Hall Construction Co.	8.72
Dodge and Hetby	7.82
J. W. Martin	[illegible]
R. H. Scott	6.90
Bunting Construction Co.	[illegible]
Mead Construction Co.	[illegible]

The contract was awarded the Mead Construction Co. May 26, 1921, and was furnished Oct. 24, 1921, the day before the time set in the contract for completion. The placing of concrete began June 27, and was completed in 120 days elapsed time.

Average daily progress for elapsed time (120 days) was 93 cu. yd. Maximum day, 328 cu. yd.; average monthly progress, 2,800 cu. yd.; maximum month, 5,323 cu. yd. Expressed in percentage the rate of progress follows: June, 2 per cent; July, 25 per cent; August, 48 per cent; September, 21 per cent; October, 4 per cent; total, 11,158 cu. yd.

Costs of Concrete and Reinforcement.—The water company furnished 15,523 barrels of cement at a cost of $2.44 per barrel, which the contractor handled for 19 ct. per barrel; 464 tons of steel bars cost the water company $2.58 per 100 lbs., including the cost of bar spacers, and was placed for $15 a ton.

Five thousand five hundred and five cubic yards of gravel were purchased at a cost of $1.53 per cubic yard, and 8,443 cu. yd. of gravel were reclaimed from the excavation as a cost of 47½ ct. per cubic yard.

The concrete was mixed 1:2:4 and required 1.39 bbls. of cement, 83 lbs. of steel and 1.25 cu. yd. of gravel.

The unit cost of concrete to the water company, excluding engineering, follows:

	Per cu. yd.
Cement	$3.40
Steel bars	2.15
Gravel	1.11
*Labor (by contract)	6.39
Total	$13.05

*Including a small quantity at $8.00.

Quantities of concrete in

Floor	5,479 cu. yds.	=	49 per cent
Walls	861 cu. yds.	=	8 per cent
Columns	366 cu. yds.	=	3 per cent
Roof	4,345 cu. yds.	=	39 per cent
Miscellaneous	107 cu. yds.	=	1 per cent
Total	11,158 cu. yds.	=	100 per cent

The labor cost of mixing and placing was $1.71⅓; fuel, 12 ct., and miscellaneous hardware, steel and repairs, 29 ct. per cubic yard.

The distribution of steel bars was as follows:

Floor	124 tons	=	0.34 per cent by volume of concrete
Walls	47 tons	=	0.83 per cent by volume of concrete
Columns	31 tons	=	1.28 per cent by volume of concrete
Roof	255 tons	=	0.89 per cent by volume of concrete
Miscellaneous	7 tons	=	[illegible] per cent by volume of concrete
Total	464 tons	=	0.63 per cent by volume of concrete

Floor Construction and Cost.—Hand grading and tamping preparatory to laying floor cost the contractor $1.50 per 100 sq. ft. The floor is formed by a series of parabolic grained arches having a rise of 18 in. on a span of 15 ft. 8 in., a minimum thickness of 9 in. and a maximum thickness of 27 in. at the columns. The column base is 28 in. square. In construction the floor was divided into two parts, the lower 4 in. was laid first as a mat, reinforced with ½ in. square twisted bars spaced 12 in. centers in two directions. This mat served the double purpose of a waterproof membrane and as the foundation for the grained-arch upper floor section.

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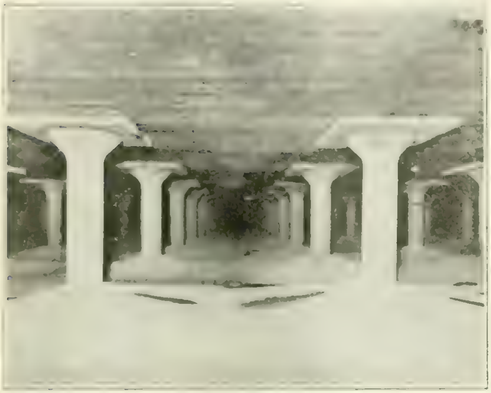
*Columns are 24 in. diameter, spaced 18 ft. center, each reinforced with eight ⅝-in. round bars and ¼-in. tie bars.

In forming the parabolic floor sections wood frames were employed whose arrises were made of heavy steel bars supported upon rectangular wooden frames. Eight of these frames were made each being used [illegible] times. The concrete was troweled smooth by [illegible] [illegible] to the surface.

The cost of setting the floor screeds for each was $1.02½ each. Contractor's superintendence, [illegible] office and bond expense are not included in unit costs quoted, but they do [illegible] [illegible] profits were realized by the contractor.

Roof, Columns and Walls. The roof slab is 9 in. thick having drop panels at the column heads 8 ft. 6 in. square extending 4½ in. below the bottom of the slab. The reinforcement was [illegible] [illegible] steel rolled into deformed bars and stressed under the assumed loading to 16,000 lbs. per square inch.

The columns and column heads are [illegible] and were formed by special metal forms rented by the contractor. The cost of setting the 420 column forms was $2.[illegible]½ each.



Interior of Filter Before Filling.

The rental of column forms sufficient to form 10 per cent of the columns at once, and the purchase of floor screeds distributed over 420 columns amounted to $6.32 each.

The walls are 15 in. thick and rest upon a footing 9 in. thick extending 12 in. outside of outer wall line, the vertical reinforcement having its anchorage in the floor and roof slabs.

The walls at the corner of the reservoir are curved to a radius of 16 ft., this expedient having been found successful in the elimination of contraction cracks at points where such cracks are usually found troublesome. Reinforcement for temperature stresses in the walls consisted of ⅜ in. round deformed bars spaced 12 in. centers in each face.

The form lumber necessary to construct 18 per cent of the wall length and 15 per cent of the roof surface, including supports for 27 per cent of the roof surface distributed over the entire surface formed amounted to 5 ct. per square foot. The cost of forming labor for roof surface was 11½ ct. per square foot and the cost of wall surface, 5 7/10 ct. per square foot.

The roof forms consisted of a series of tents or trussed [illegible] made from 2 in. x 8 in. planks doubled, which were spaced 3½ ft. centers and lagged with 2 in. x 8 in. planks. These tents were erected upon wedges. At the center point of each panel between columns a 4 in. x 6 in. prop was left standing for 7 days after the centers had been struck.

The drop panels around columns were made of wooden [illegible] in two sections and were used about 7 times. Wall forms were made in unit sections, each 4 ft. wide, using ⅞ in. tongue and groove sheathing placed vertically, reinforced by 2 in. x 6 in. ribs placed horizontally and with steel flanges at the sides for bolting the sections together. Four 4 x 6 inch horizontal wallings spaced 24 in. centers were bolted through the wall at intervals of 30 in. by ⅝ in. round rods held by set screw clamps. These rods were left in place after the removal of forms and the ends burned off flush with the wall and plastered with pitch.

Concrete Equipment. The contractor's equipment consisted of one 18 cu ft Koehring mixer mounted upon a platform forming the base of a tower 74 ft. high and located beneath a charging hopper or bin holding 45 cu. yd. of gravel. The tower supported one concrete chute, 30 ft. long and two counter balanced chutes, one 40 ft. and one 50 ft. long, giving a working radius of 120 ft. This apparatus was mounted upon rollers for convenience in moving. The chute system was manipulated from a 70 ft. boom attached to the base of the tower and the elevating bucket operated by a Byers single drum hoisting engine. The hopper was charged by means of a Clyde, 2 drum hoisting engine, mounted upon a stiff leg derrick mounted upon rollers and having a 70 ft. boom and ¾ yd. clam bucket. In addition to this outfit the contractor used a Jaeger ½ sack batch mixer for placing floor concrete.

The larger mixing plant was first placed in the center of one end of the structure, and was moved 8 times down the center to the opposite end, finishing floor, walls and roof as the derrick moved along. Day-joints were properly bulkheaded and keyways left in all bulkheads. Immediately upon the completion of one portion of the roof the margins of the day's work were dammed with a small mortar edging and water about 1½ in. deep was permitted to fill the enclosure; this procedure resulted in eliminating surface checks by keeping the fresh concrete saturated, and also tended to keep the temperature of the concrete from rising during the hot days of midsummer. No expansion joints were provided, dependence being placed upon the steel bars, keyways and the density of the concrete mixture to produce a monolithic and waterproof structure. The centers were removed seven days after pouring a section of roof slab, leaving, however, one 4 in. x 6 in. prop in the center of each span between columns in two directions. In seven days more these props were removed, and in two more weks or 30 days from date of pouring the earth fill was distributed over the roof in layers 7 to 10 in. deep.

It must be borne in mind in this connection that the work was practically all done in midsummer when weather conditions for curing the concrete were most favorable. The roof surface was smoothed with wood floats. Bar spacers to properly align and space the reinforcing bars were employed throughout, with metal high chairs at the column heads to maintain the steel in its proper position.

Manholes and Ventilators.—Eight manholes and four ventilators are provided for ready access and ventilation. The reservoir is divided into three passes by two baffle walls which provide for the uniform circulation of water through all parts of the basin. They are constructed of 4 in. brick walls joining columns, and extend to the column heads, the walls being reinforced at the middle point of each panel by a 12-in. square brick column. Sixty thousand bricks were used in these walls.

Connections.—Piping connections are provided so that water may enter or leave the reservoir at three points. One of these connections communicates with an adjoining reservoir of less capacity through a controlling chamber having a drain connection by means of which either reservoir may be emptied and cleaned independently. Another of these connections enters a sump or suction well, making practically the entire contents of the reservoir available to the pumps. Pipe connections are 4.8 in. diameter. The structure is an excellent example of good workmanship in concrete, and the water company has every reason to be gratified by the able and efficient manner in which the work was handled by the contractors.

Piping connections were completed and the reservoir placed in service in January, 1922.

Acknowledgment is made to the Mead Construction Co., Indianapolis, for the cost data furnished, to B. J. T. Jeup, Chief Engineer Indianapolis Water Co., under whose direction the work was executed, and to Leonard Metcalf, Consulting Engineer, Boston, for helpful suggestions.

Increased Rates at Ashtabula, Ohio. An increase in city water rates, ranging from 6⅔ to 17 per cent, will go into effect when the new franchise is granted to the Ashtabula Water Supply Co.

The old franchise expires May 22 and council has agreed on the increase.

Some Phases of the Stream Pollution Problem

Work of U. S. Public Health Service Explained in Paper Presented at Meeting of Illinois Section, American Water Works Association, March 29, 1922

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The increasing pollution of our streams and coastal waters has been for a considerable time a matter of serious concern to sanitarians and those interested in the promotion of our public health, and is bound to become a more difficult problem as our population increases, and these waters are used more intensively in the industries and as sources of public water supply. The problem is an intricate one and touches on some phase either directly or indirectly the welfare of the entire population.

There are several viewpoints from which stream pollution must be considered, more or less overlapping, yet distinct, namely, the economic, the aesthetic or recreational, and the effect on public health.

The Economic Phase.—The economic side of the stream pollution problem is one that has been given little consideration until recently, but is gradually coming to be accorded the importance it deserves. Much has been said and written, demanding a return of the pristine purity of our water courses and the elimination of every polluting agency, regardless of the cost of such elimination. The practical absurdity of this position is becoming more and more apparent, however fine it may prove in theory. The requirements of modern civilization demand an intensive use of our natural resources and the reasonable use of the natural water courses cannot be excluded from this requirement, since they constitute one of our greatest national assets. There are then, real, practical, economic limits beyond which it is unwise to go, in forcing abatement of stream pollution, and the determination of this limit for each individual stream presents a problem in itself. Thus, an economic study of a definite situation may disclose that it would be cheaper to procure a new source of water supply for one small municipality rather than to treat the sewage of a large up-stream city; or it may be found more economical for an industry to change its location entirely or even go out of business, rather than to incur the unreasonable expense of treating a refractory industrial waste. In general, the value of benefits to be derived from stream purification must be weighed against the costs of elimination of pollution.

The Recreational Phase.—Most streams are used to a considerable extent for recreational purposes, such as bathing, fishing and boating, which use is greatly retarded or even eliminated if excessive pollution is allowed to occur. The value of this use is generally intangible and difficult to state in dollars and cents, but is, nevertheless, real. Perhaps the most commonly heard descriptive illustration of the excessive pollution of any stream is the one that all the fish have been killed in it. To be unable to catch fish in the brook that was formerly the ideal fishing place of our boyhood, expresses the superlative in condemnation of pollution in that particular stream, and it must be confessed that the nature and variation of fish life present is a sensitive indicator of the extent of pollution in any water course. Boating and bathing are also affected by excessive pollution and in many cases such usage of a polluted stream becomes an important public health problem. The esthetic senses also revolt at sight of grossly polluted water courses.

Floating debris, garbage and sewage deposited along the banks, ebullition of gas from decaying sludge in stream beds, and highly discolored waters from domestic and industrial wastes afford ample grounds for complaint and demand for betterment of such conditions. While all of these factors are of secondary significance from the standpoint of health or economics, they constitute a most important phase of the stream pollution problem and the one that is, and will be, responsible for the largest share of public support in any movement for elimination of objectionable pollution.

The Public Health Phase.—The effect of stream pollution on public health is undoubtedly the most important phase of the problem. We must depend primarily on our streams for sources of water supply, and in the interest of health, we must above all demand that these supplies be adequate and free from contamination. If streams are to be used for water supplies, they must either be unpolluted or methods of artificial purification of the water must be adopted to insure a suitable standard of quality. Our present knowledge of the art of water purification is such that it is economically impossible to produce pure water in quantity from a grossly contaminated source. The effluent from any purification plant bears a very definite relation to the condition of the raw water, and hence it is important that sources of water supply be not polluted beyond a certain point, if the health of the community using the supply is not to be imperiled.

On the other hand, public health demands the prompt and efficient removal of body wastes, and this has been found to be best accomplished by the water carriage method of disposal. The proper method of treatment and disposal of these liquid wastes, or sewage, is therefore a public health problem closely allied to that of stream pollution and public water supply.

Study Authorized by Congress.—Because of the increasing seriousness of stream pollution, as affecting interstate water courses and the demand for remedial legislation for such conditions, Congress, in 1912, authorized the Public Health Service to "investigate the diseases of man and conditions influencing the propagation and spread thereof, including sanitation and sewage, and the pollution either directly or indirectly of the navigable streams and lakes of the United States." In compliance with this authority, the Service organized and has since conducted researches to determine the fundamental factors operative in the processes of stream pollution and stream purification. The scope of the study was made sufficiently broad to cover the various types of problems to be met with, and was divided into three separate parts.

A study of the coastal waters and tidal streams was undertaken under the direction of Surgeon (now Surgeon General) Cumming. Much information was obtained on the effect of pollution on the shellfish industry and methods were developed for counteracting this pollution as it affected the production of shellfish.

Studies of the nature and treatment of industrial wastes were conducted under the supervision of Prof. Earl B. Phelps. Experimental treatment plants were operated for sufficiently long periods of time to demonstrate the most effective method of handling various types of industrial wastes, and at the same time much detailed data was collected pertaining to the nature and constituents of these trade wastes. The results of these studies have been published as Bulletins of the Public Health Service. Both of these lines of study have been necessarily discontinued, temporarily, at least, because of insufficient funds to carry them further.

Studies of stream pollution and stream purification, as pertaining to the inland rivers, have been organized and continued under the direction of Surgeon W. H. Frost. Intensive studies of the various phenomena operative in stream purification have been carried on, interrupted during the period of the war, with Cincinnati as a headquarters.

The greater part of the field work has been conducted on the Ohio River and Ohio River watershed. More recently the Illinois River has been under observation to determine the general applicability of the fundamental laws observed on the Ohio River work.

Objects of the Studies.—These studies have been promoted with certain definite objects in view, although complete attainment, it is realized, will require a great deal of time and the expenditure of considerable labor. These objects may be briefly discussed in passing.

The first object is to determine the actual nature of the various important primary types of polluting substances in fundamental terms, and then to ascertain and evaluate the effects of each when discharged into a stream. An intelligent study of stream pollution cannot be undertaken unless we take into account the origin and constitution of various polluting substances. This means that the actual agencies of pollution must be carefully considered and these various forms of pollution be reduced to some common standards of measurement. We must know of what domestic sewage consists, what the properties of such sewage are, and, if possible, reduce these constituents or properties to some definitely determined units such as the amount of oxygen required to oxidize the organic matter contributed in the per capita contribution.

In the same way we should know the characteristics of the various industrial wastes so that all of these may be reduced to fundamental and common units. Thus, for packing house wastes, we should know some unit such as the average amount of nitrogen contributed to the waste per animal slaughtered or the average amount of oxygen used up in oxidizing the wastes resulting from each animal handled. If some such relationships can be established then we can say that for instance a contributing population of 1,000 will require a definite number of pounds of dissolved oxygen in the stream to oxidize the sewage, or that 1,000 animals will contribute a definite number of pounds of nitrogen to the wastes from the packing plant in which they are slaughtered, or will require a certain amount of oxygen for oxidation of the wastes. Similar fundamental units are necessary for each of the important industrial wastes that go to make up the combined pollution contributed by the community. Where there are particular wastes of importance being contributed, such as for example the wastes from corn products industries, these should be studied in a similar way, so that their effect on the stream may be stated in readily ascertainable units of production, such as per bushel of corn used.

What Are the Laws of Stream Purification?—Another object is to discover if possible, the fundamental laws, if such exist, that operate to produce the phenomenon of stream purification. This observed purification is a progressive process that gives evidence of following definite fundamental laws, although these may be very complex and not easy of determination. There are many functions that modify the rate of purification, and these may be so interwoven and combined as to prevent separate analysis. Certain it is that the old statement, that a flowing stream purifies itself in seven miles, is far from correct. We know that velocity, or time of flow, is a controlling factor rather than distance. Temperature, both of the water and of the superimposed air, turbulance of the water, and the physical content of the water itself, exposure to light and air, all of these, together with others, are factors that affect the rate of purification. Each must be studied under controlled conditions, if sound theories of purification are to be evolved.

The third object is to determine what agencies are active in the process of stream purification and the significance of the role of each agency in this process. It is necessary to know, for example, what particular organism or constituent is responsible for a specific, observed change in the chemical composition of the various compounds constituting pollution; what role such organism or constituent plays in affecting such specific change, and what is the significance of each of these factors. This is in itself a complex problem and one about parts of which little is known. We know, for instance, that in the purification process, the death rates of bacteria are a measure of the rate of purification, but we do not know what that death rate is, to what it is due, or what all of the factors are that retard or accelerate it. We believe that the plankton, both animal and vegetable forms, play an important role in purification processes, but we know very little about their specific activities and their food habits, or the net effect of the products they generate, such as oxygen for instance.

We know that certain classes of organisms break down into simpler forms the organic matter present as polluting substances, but just what these processes are we cannot say. We know that the process of purification depends upon the oxidation of organic matter present, but we know little of the rates at which this oxidation proceeds, or the factors that hasten or retard this rate. We know that in the process of purification certain chemical changes take place, but with our present knowledge we have great difficulty in interpreting the meaning of these changes, modified as they are by so many other active agencies. These are some of the many problems to be solved if we are to have an understanding of what may appear at first thought to be the simple problem of stream purification.

Large Streams and Complex Conditions.—Another object of the Service studies is to make a practical study of polluted streams that are of sufficient size and representative of average conditions, to determine the net effect of various types of pollution where these types are mixed in a practical way, and to verify the theoretical conclusions arrived at concerning stream purification. After the required data are obtained regarding the nature and extent of the various polluting wastes, their actual effect on the water course into which they are discharged must be observed, and the rate at which the stream is able to recover from the pollution load must be determined. These observations should cover sufficiently long periods of time and be of broad enough scope in order that the conclusions drawn may be of general application in other places where similar sets of conditions occur. This is the phase of the problem that is now being studied by means of the laboratories located along the Illinois River, and which will be discussed in detail later.

Practical Applications.—Another object is to make the results of the studies of practical value and general application, so that costly and tedious technical investigations need not be conducted in each individual case to determine the stream conditions to be expected from known amounts of pollution. This is, perhaps, the most difficult problem of all; but if the solution be capable of clear statement, it should be of great value in determining for any stream what degree of purification may be anticipated at any point due to a known amount of pollution being contributed at some point upstream. That is, if to any stream of known volume and velocity of flow, we know a population of say 100,000 is contributing domestic sewage, we should be able to determine within reasonable limits the amount of pollution that might be expected to be present at a point 100 miles downstream at a waterworks intake; or, again, we should be able to estimate the effect on a surface water supply of say an increase of 50,000 inhabitants on the upstream watershed, or the additional load that such an increase might be expected to contribute to a water purification plant. These conclusions should be possible without the use of extensive and costly laboratory examinations covering extended periods of time. Furthermore, such complete surveys should be of aid in establishing reasonable limits of permissible pollution and indicate the point at which treatment of wastes must begin if objectionable conditions in the receiving stream are to be avoided.

The Work and Organization of the U. S. Public Health Service.—These are some of the phases of the stream pollution problem that the Public Health Service has begun to study. Much preliminary work has been necessary to devise and perfect methods and to collect existing data and reduce previous independent studies to comparable terms where it might be of value. To obtain the greatest benefit from the organization dealing with the study of interstate streams, the work was separated into three main divisions, all of which have been carried on simultaneously with the objects in view as outlined above.

Experiments on Polluting Agencies.—The first division has been conducting studies and experiments on the nature and effect of polluting agencies. Analyses of various classes of industrial wastes and sewage have been carried on, to establish, if possible, the relationship between constituents of the waste and fundamental factors active in the production of the particular waste, regardless of the volume of the waste itself. Thus, in scouring a pound of wool, a relatively uniform amount of nitrogen is contributed to the washing waters, regardless of whether the amount of water itself is great or small, and similarly, for domestic sewage certain constituents are more nearly proportional to the per capita population contributing than to the volume of sewage discharged. The most economical methods of treatment of such wastes have been studied at the same time.

Phenomena of Purification.—The second division of the study has been concerned with the phenomena of stream purification. Detailed data are being assembled dealing with the nature and extent of various kinds of pollution being contributed to certain large streams; studies are being made of the hydraulics of these water courses, such as their velocities of flow, and amounts of water contributed by tributaries and other sources of inflow, and, in addition, laboratories for studying the actual degree of purification being effected at various points throughout their courses, are being operated for sufficiently long periods of time, to supply reliable data.

Effects of Pollution on Public Health.—The third division of the work has to deal with the effect of intensity of pollution on the public health, principally through the agency of the public water supply. This has involved a rather detailed study of the present methods of water purification and treatment in various types of plants, and the efficiencies of such plants under varying pollution loads. Studies have also been made of the actual conditions of public health in different communities, where various types of treatment plants and varying grades of water are being supplied for consumption. This work has included the making of detailed sanitary surveys of every municipality having 10,000 population, or over, on the Ohio River watershed, as well as of the greater number of cities in the Eastern and North Atlantic States.

Work on the Illinois River.—As a part of this general program, a study of conditions existing throughout the Illinois River is at present in progress. The work is not being done primarily from the viewpoint of a local problem, although some phases of it are of considerable local interest. From what has been said, it is evident that a study to fulfill the objects of the Public Health Service, as outlined above, must be made on a stream where all possible factors can be obtained in definite well-defined units, if results of general application are to be secured. Hence it is advisable to choose for such study a stream where definite values are obtainable to the greatest extent. The Illinois River meets these requirements to a considerable degree.

Th pollution contributed to the Illinois is largely added at one point and from a definite well-defined area. There is very little dilution of this pollution effected by tributaries of the main stream, so that the observed degrees of pollution noted at various points along the channel need not be corrected appreciably because of such modifications.

The sources of pollution are definitely known, or are readily ascertained. The population discharging sewage into the main drainage canal is clearly defined. Likewise the nature and extent of the various industries in this area have been enumerated and data are available relating to the nature and amounts of industrial wastes discharged to the drainage canal.

The volume of flow of the Illinois River is also capable of determination and the amount of water diverted from Lake Michigan is a matter of record. Surveys of the entire river channel have been made by the U. S. Corps of Engineers, who also maintain gages throughout the stream whereby the daily flow at any point can be computed.

Much additional pertinent data has been collected by other state and local agencies which, being available, has made the Illinois a most attractive stream for a study of the kind at present being undertaken.

Coming now to the present study of the Illinois River, this work has been separated into three main divisions, all of which are being carried along simultaneously at this time, consisting of hydrometric studies, sanitary surveys, and laboratory analyses of samples of river water.

Hydrometric Studies.—The hydrometric studies consist in making field determinations of the daily flow of the main stream, at various points, and of all tributaries as they discharge into the main stream. This is done by making frequent current meter measurements of flow at various known gage heights. Numerous gages carefully located are read daily, and from these records the daily volume of flow is computed, using the current meter measurements as a basis. A considerable amount of this work is being done in cooperation with the U. S. Geological Survey, which is furnishing most of the gage readers. This data is being assembled in such a way that it will be possible to state in reasonably accurate terms the total amount of water passing any sampling section on any day and the volume of water added to the mainstream by each of the important tributaries of the Illinois. The amount of water being diverted daily from Lake Michigan is also known, so that the total volume of stream flow is determinable.

Another phase of the hydrometric studies has to do with the determination of the velocity of flow throughout all parts of the river. Because of the complete channel survey made by the United States Corps of Engineers, the most feasible method of determining the velocity was found to be by means of the displacement method, correlated with slope of channel as indicated by gages placed throughout the stream length. These computations are so arranged that it is possible to determine the time consumed for the water to pass from one sampling section to the next below, and in that way establish the effect that has taken place in such time interval.

Sanitary Surveys.—Sanitary surveys have been practically completed of all important industries and municipalities contributing wastes to the stream to determine the extent of the contribution of pollution. Much of this data had been previously collected by various organizations, but personal visits have been made to industries and towns along the river where data were not otherwise available. It is hoped by this information to establish in fundamental terms the relationship between known numbers of population and pollution effect observed in the stream.

Laboratory Studies.—The laboratory studies having to do with the actual determination of the daily condition of the river water at numerous points throughout the course of the stream have been the most tedious and expensive part of the study. In order to obtain reliable results the laboratory work must be carried on over a sufficiently long period of time to observe seasonal and other changes that may take place. Needless to say, the work must be thoroughly standardized and accurately performed, in order that results from all laboratories are strictly comparable in every respect.

Four laboratories have been established on the Illinois River, the main laboratory and headquarters at Peoria, and branch laboratories at Joliet, Beardstown, and Kampsville. The locations were so chosen that samples from practically every section of the river could be delivered to one of these laboratories promptly for complete examination. Definite sections were established, from which daily samples could be collected, and either brought or shipped by express to the most accessible laboratory. A special type of sample collecting apparatus was devised by means of which bacteriological and chemical samples can be taken in separate bottles at the same time, and from the same water stratum. It is hoped to continue this intensive laboratory work over a period of a complete year.

The analytical work has followed three principal lines—bacteriological, chemical and biological.

Daily bacteriological analyses are made on all samples received, in strict accordance with carefully standardized technique and by carefully trained bacteriologists. All of the culture media is made at a central point and in accordance with standard methods. The bacteriological determinations consist of numbers of bacteria growing on gelatin at 20 degrees Centigrade in 438 hours, and on agar at 37 degrees in 24 hours, and the numbers of B coli computed by the decimal dilution method. Differentiation of types of B coli, grain or fecal, by means of dextrose peptone phosphate broth, is made on a certain percentage of all Coli cultures isolated.

The chemical work has been considerably reduced because from past experience it has been found that many complete mineral analyses are not justified. The alkalinity and turbidity are determined for all samples collected, as well as the immediate dissolved oxygen. The biochemical oxygen demand is also determined for every sample, using the dilution method and incubating the sample for a period of 5 days at a temperature of 20 degrees Centigrade, and ascertaining the dissolved oxygen present at the end of this incubation period. We believe this to be one of the most valuable tests at present in use for indicating the degree of pollution and the rate of purification that may be expected to occur from such pollution.

Composite samples, covering periods of ten days, are made, preserved with sulphuric acid, and analyzed for certain constituents such as oxygen consumed, free ammonia, Kjeldahl nitrogen, and nitrogen oxides, including nitrates and nitrites. It has been found by a careful series of experiments that the sulphuric acid preserves such samples without change for a sufficiently long period of time to make this method entirely practicable.

The biological part of the laboratory studies has been designed to more or less supplement the extensive work of the State Natural History Survey, and to correlate the present findings with the observations so carefully made by Professor Forbes and his workers. Consequently, only a small part of the biological field is being touched upon. Monthly samples of bottom sediment are collected at selected points and the nature and amount of the content of these various sludge deposits noted. Weekly samples of plankton are collected from much more frequent sampling stations, and these plankton forms counted, identified, and recorded. Special attention is being paid to the presence of those forms which in their processes of development generate and impart oxygen to the surrounding water, and thus influence the rate of oxidation of the organic matter present.

A map of the Illinois watershed has been prepared showing the location of the laboratories, indicated by large symbols, while arrows with small symbols indicate the points at which daily samples of water are collected for analysis. Sampling stations indicated by a certain symbol, such as a triangle, indicate that samples from this point are analyzed in the laboratory designated by a similar symbol.

The data being collected has not yet been arranged in final form, so that it is not practicable at this time to draw definite conclusions as to the rates of purification to be expected, although in a general way the results seem to follow the same general trend of those obtained in the Ohio River work.

Cross Connections By-Passes and Emergency Intakes on Public Water Supplies

A valuable report on this subject was presented at the last annual conference of State Sanitary Engineers held at Boston, Mass., last June, by a committee consisting of S. Pincus, Chairman, C. A. Emerson, W. H. Dittoe, H. F. Ferguson and M. Z. Bair. The report was unanimously adopted by the Conference. An abstract of the report, prepared by S. Pincus, appears in the March Journal of the American Waterworks Association, to which we are indebted for the matter following.

The importance of giving increased recognition to the casual and indirect methods of impairing the quality of a water supply, or to the occasional and emergency situation whereby the public water supply may become unsafe, is stressed in this committee report of the State Sanitary Engineers' Conference. With the public water supplies rapidly reaching a generally safe sanitary quality, it becomes steadily more important that the water furnished cities be protected from insidious or accidental infection through ways that some would consider more or less remote. The part played by cross connections, by-passes and emergency intakes on public water supplies in the production of the typhoid fever rates of American cities has been overshadowed by the typhoid fever caused by the usual impurity of the water supplies or by the common prevalence of other unsanitary conditions producing typhoid. The improved sanitation of our cities and the better quality of our water supplies which have made it possible to obtain the very low typhoid death rates of the last few years, will make more evident the effect of the ever present hazards, though only sporadically encountered, that are inherent in these physical connections to dangerous water supplies.

The committee secured data from thirty state departments of health concerning their procedure and attitude on these devices. The great majority of the states had no defined policy on the problem of permitting or supervising these devices. Only a few states have made any investigations or studies in this connection. But fifteen states could give figures on the number of public water supplies having by-passes, emergency intakes or cross connection. Three states have specific regulations against cross connections, while ten other states report their opposition to any form of cross connections. Replies from ten cities among the largest in the country to a questionnaire sent in 1918 showed these cities to be unanimously opposed to any kind of cross connection.

Twenty outbreaks of typhoid fever, dysentery or gastro-enteritis occurring in eleven states in recent years were caused by cross connections (11), by-passes (4) or emergency intakes (5). Outbreaks of disease were reported where cross connections had been provided with a check valve and gate valve.

The committee urges the need for the fixing of a definite and secure policy upon these connections to the public water supplies in every state and has recommended the following definitions and principles for guidance in the establishment of such policies.

Recommended Definition and Principles for Cross Connections.—A cross-connection is a physical arrangement whereby a public water supply system is connected with another water supply system, either public or private, in such a manner that a flow of water into such public water supply system from such other water supply system is possible.

Principle No. 1: No cross-connections should be established or maintained between the public water supply system and any other water supply system, private or public, unless both water supplies are of safe sanitary quality and both supplies and the connection thereof have received the approval of the state health department.

Principle No. 2: In cases where it is necessary or advisable to supplement an impure private water supply with the public water supply distributed in the same piping system, the public supply must be made available by delivering it into a cistern suction well or elevated tank, at an elevation above the high water line of such cistern, suction well or tank.

Recommended Modifications of Above Principles for Temporary Application Under Exceptional Circumstances.—While the committee is of the opinion that full safety demands such complete separation of the public water supply system from other water supply systems delivering impure water, the committee recognizes the relative degree of safety which can be provided by suitable check valve installations on connections between a public water supply and a piping system used for fire protection only.

The committee is cognizant of the fact that such connections may be proper and reasonable under certain conditions, and desires to express the following requirements which should be met in making and maintaining such installations:

1. Cross-connections should not be permitted where the available public water supply or private fire protection supply is adequate for fire protection purposes.

2. That the fire protection piping system shall not be connected with any other piping system upon or within the property served, and that there shall be no outlet from such fire protection piping system except through sprinkler head, fire plugs and hose connections. This requirement is intended to prevent a flow through check valves except at times when a sprinkler head, fire plug or hose connection is open.

3. The cross-connection shall be equipped with such devices as can most effectually prevent an inflow of water from the fire protection system to the public water supply system.

4. The committee is of the opinion that the most efficient and dependable device developed up to date (aside from the method described in Principle No. 2 above) is the check valve installation recommended by the Associated Factory Mutual Fire Insurance Companies of Boston, Mass., consisting of two gate valves with indicator posts, two check valves of the Factory Mutual type, with drip cocks and gauges for testing, an alarm valve equipped with a recording pressure gauge, a by-pass meter around the alarm valve, all to be placed in a vault of water-tight construction accessible to ready inspection.

5. A systematic test inspection of the cross-connection, including periodic examination of the interior of the check valves by the department in charge of the public water supply system, must be provided, without which inspections the installations of the cross-connection would be a highly dangerous health menace. The inspection must therefore be made reliable, thorough and responsible.

6. The committee views as a self-evident requirement that in every case where a cross-connection is being considered for approval a thorough investigation will be made as to local conditions and as to the necessity and advisability of the cross-connection, and that the local municipal officials will be made fully acquainted with the circumstances and given due opportunity for presenting their views.

Recommended Definitions and Principles for By-Passes.—A by-pass is a physical arrangement whereby water may be diverted around any feature of a purification process of a public water supply.

Principle No. 1: No by-pass should be established or maintained whereby water may be diverted around any feature of a purification process of a public water supply system, provided that with the specific approval of the State Department of Health by-passes may be permitted around primary sedimentation basins, aerators or mixing chambers.

Application Recommended.—Where there are existing by-passes, except as provided above, the correction should be obtained by the complete removal of the by-passes or the removal of a section of the by-pass piping.

Definition and Principles for Emergency Intakes.—An emergency intake is an intake or other device capable of introducing water into the public water supply system from a source of supply which, because of its unsafe characteristics, has not been approved for ordinary use by the State Department of Health.

Principle No. 1: No emergency intake should be established or maintained in connection with a public water supply system.

Application Recommended.—Where emergency intakes are in existence and where the regular water supply is adequate and the emergency intake can be safely removed, the emergency intake should be completely taken out so as to be unavailable for use.

Where the regular water supply system is not adequate and the maintenance of an emergency intake is conclusively necessary, it is obvious that such intakes must be continued, but should be under the complete supervision of the state department of health so that the intakes will not be used except under conditions constituting an emergency. During the continuance of the emergency intake, the state department of health should make every effort to obtain the enlargement of the existing water supply plant so that the emergency intake may be removed at the earliest possible time.

For the maintenance of an emergency intake, under the above mentioned circumstances, the following safeguards should be adopted and enforced:

1. (a) The water-tightness of the valve on the emergency intake connection should be tested and the valve sealed by the state department of health or (b) the valve should be sealed and a section of the intake piping should be removed, making it necessary to replace the pipe section before the intake is available.

2. Provision must be made for the chlorination of any water taken through the emergency intake before delivery is possible to the distribution system.

3. Whenever it becomes necessary to open the emergency intake, the waterworks official must give immediate notice, if at all possible, preliminary to the opening of the intake, to the public affected and to the state and local health officials. The disinfection equipment should be placed in service immediately and a warning given to boil all water used for drinking and domestic purposes. Such warning should be continued until the emergency intakes is again closed and sealed, and the water supply system cleansed and declared safe by the state health department.

Service as an Element in Rate-Making*

By CARL WILDE,

Director of Service, Public Service Commission of Indiana.

The principle, fully recognized and applied, that the character of service rendered by a utility should be taken into consideration as an important element in determining its rates, is of great assistance to the service department in that it aids that department to induce utilities to adopt proper standards and rules of service.

Commission Rulings.—This principle has been recognized by various commissions for some years. On December 30, 1915, the Wisconsin Commission denied a telephone company the right to increase its rates on a line serving only a few subscribers, giving inadequate service and yielding an inadequate rate, until adequate service be established and a reasonable effort be made to secure additional subscribers. The commission said further that if the telephone company should prove unable to give satisfactory service after a reasonable trial period, the commission would not then oppose the extension of the line of a competing telephone company into the district in question.

In 1919 the Nebraska Commission, in establishing a new schedule of increased telephone rates for a utility operating in several communities, made an exception to the general rate increase in favor of subscribers connected with a certain line, where the evidence showed that the line was in very poor service condition.

The Arizona Corporation Commission has ruled that in considering the adequacy of telephone rates service is one of the principal features to be borne in mind, the subscribers as a rule being willing to pay properly for service which meets their needs adequately.

My own experience in the service department of the Indiana Commission has convinced me that this is true. I have been told time and again by utility patrons that they would not object to paying an adequate rate if the service they received was adequate, but that they objected strenuously to paying adequate rates for inadequate service.

The Michigan Public Utilities Commission has also laid down the principle that the quality of the service rendered by a telephone utility should be a vital factor in the determination of its rates.

The Oregon Public Service Commission in discussing the relation of service to rates said:

"This commission naturally concedes the relevancy and importance of a financial showing, but certainly not to the exclusion from our consideration of the general service conditions, and other circumstances surrounding the case, and in this order we must, in fairness and equity to the company's patrons, emphatically reaffirm that the adequacy of the service bears a direct and important relationship to the reasonableness of the rate."

The Missouri Public Service Commission has enunciated the same doctrine, using in one case the following language:

"The subscribers should not be required to pay for the service more than it is reasonably worth. The extent or quantity as well as quality of service must be considered together in their relation to each other, because it is apparent in the record of this case, that the quality of the service has been affected by the extent or scope of the service."

In a case which directly concerned water rates the Missouri Commission said:

"It is the duty of the company to make whatever additions and alterations are necessary to provide not only for the domestic consumption, but as well for fire service by direct pressure, and when the company is prepared to discharge this duty, and not until then, it may properly claim such rates as may be necessary to provide for a net return on the investment used and useful in the public interest.

"The water company is not rendering such reasonable fire service as the city is entitled to receive; the granting of rates which will produce a fair return on the investment used and useful in the service of the public is predicated upon the furnishing of reasonably satisfactory service, and until the company is prepared to furnish such service, it is not entitled to an increase in rates and charges for water service."

Rulings by the Indiana Commission.—The principle that the character of service rendered by a utility should be taken into consideration as an element in rate-making has been discussed in various cases by the Public Service Commission of Indiana.

In its Cause No. 5107, which arose upon the petition of a water utility for increased rates, the commission used the following language:

"The commission is of the opinion that while petitioner is entitled to increases in its water rates, the patrons are entitled to better service. The commission will authorize certain increases in water rates, with a distinct understanding that service conditions must be improved in the immediate future. If petitioner fails in its duty to its consumers, the commission will entertain a petition to reconsider its present findings and reserves the right to initiate proceedings to annul the water rates herein authorized."

In its Cause No. 6229 the commission on the petition of certain consumers reduced rates because of inadequate service. Omitting the name of the city and the utility, the commission in that cause said:

"If the gas service at ——— was adequate, the commission would have no choice, under the law, but to deny this petition and continue in effect the present rates.

"Section 7 of the Public Service Commission Act provides: 'Every public utility is required to furnish reasonably adequate service and facilities. The charge made by any public utility for any service rendered or to be rendered, either directly or in connection therewith, shall be reasonable and just, and every unjust or unreasonable charge for such service is prohibited and declared unlawful.' A public utility is entitled to earn its proper operating expenses, including taxes and depreciation and a reasonable return on the fair value of its property, if it furnishes reasonably adequate service. The evidence in this case shows, and at the hearing respondents admitted, that the gas service in ——— is inadequate. Petitioners submitted the testimony of a large number of witnesses whose residences were distributed over the city, so that practically every section of the city was represented * * * the company frankly conceded that its service was not adequate and admitted the correctness of the complaints of the witnesses who did testify. The evidence does indicate beyond a doubt that the gas service at [illegible] has been inadequate for at least a year and probably for several years, and that it is now inadequate."

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*A paper presented before the Indiana Sanitary and Water Supply Association, March 22, 1922.

"The ——— Company has a monopoly of the gas business at ———. It purchased the plant and business and entered the territory knowing that the law required adequate service at reasonable rates. It has on its own initiative assumed the burden and responsibility of operating a gas utility at ——— in accordance with the requirements of the law and it has assumed the burden of furnishing adequate equipment and [illegible] properly installed. It has assumed the burden of supplying competent and efficient management. The owners of this utility have no reason or right to expect that they ever will be permitted to earn a reasonable return on the value of their gas property at ——— unless and until they give adequate service to the public and furnish the character of service which the consumers have a right to expect and demand."

In the Cause No. 5286, which arose upon the petition of a telephone company for an increase in rates, the Indiana Commission employed the following language:

"The commission believes that the term 'adequate service' extends beyond mere mechanical service—the ability in case of a telephone utility, quickly and accurately to obtain the number called. It includes also a proper attitude on the part of the utility towards the public. The commission believes that a utility intrenched behind a bad financial showing cannot demand increased rates as a matter of right, regardless of its service to the public and its relations with the public. * * * The commission believes that rates should not be increased until service is made reasonably adequate—directly by increased mechanical efficiency and indirectly by a better attitude toward the public."

From the foregoing excerpts from decisions of the Indiana Commission it will be noted that that commission fully endorses the view that the character of service rendered by a utility should be taken into consideration as an important element in constructing rates.

The Author's Observations.—Indeed it is difficult to conceive of a proper rate structure which does not take into consideration the character of the service given. I have heard counsel for utilities contend that service is not an element in rate-making, but it strikes me that this contention is capable of being reduced to an absurdity. Let us assume, for example, that there are two cities or towns of precisely the same population, topography, area, climate and abundance of water supply. In city "A" a water company is operating and the value of its plant is $100,000. In city "B" another company is operating and the value of its plant is also $100,000. Operating expenses are practically identical but in "A" the water service is inadequate, frequent breakdowns occurring due to carelessness and inefficiency; domestic and fire pressure varying and not adequate. In "B," on the contrary, the service is excellent and adequate pressure is maintained at all times. Would it not be an absurdity to cause the water consumers in "A" to pay for their inaedquate service as high a rate as the water consumers in "B" pay for their splendid service? To make the same rate in both of these cities would be to place a premium on negligence and inefficiency and to penalize the consumers who must pay an adequate rate for inadequate service.

Of course no two cities are identical in size and conditions but they vary in degree only and what is true in the hypothetical case is true in reality.

The foregoing reasoning is only applicable where a monopoly exists. In cities and towns where there are competitive utilities competition will take care of differences in service and the utility whose service is bad will soon find that all its customers have gone over to its competitor. This is almost the only advantage that I can think of that can [illegible] accrue from a competitive utility situation and that is certainly obviated where rates are properly constructed taking the nature and adequacy of the service into consideration as an important element.

To permit a utility to lower its standard of service is to permit the utility to increase its rates. When a rate is fixed a certain standard of service exists and if that standard is subsequently lowered there results automatically an increase in rates because the utility is giving less for the authorized rate than was contemplated at the time that the rate was granted.

It seems, then, that a sound public policy would dictate recognition of the rule that the character of service should be taken into consideration in fixing rates because there should be a premium on good service, or to state the matter inversely, there should be a penalty for poor service.

Conclusions.—Let me in conclusion deviate for a few moments to speak of public relations as an element of service. In one of the decisions of the Indiana Commission quoted in this paper, unsatisfactory public relations were coupled with inadequate service as grounds for refusing an increase in rates. My observation, and such little experience as I have had, convince me that no service, however adequate from a mechanical or technical standpoint, can be acceptable and satisfactory to the public served unless the relations between the public and the utility are such that there is courtesy and forbearance on the one hand, and confidence and forbearance on the other. Most utilities are corporations and most of them have a monopoly within their territory. The public, because of an indiscriminate damning of corporations and monopolies generally by a certain type of public speaker, and a particular species of periodical, have come to look askance upon any organization to which those two terms can be applied. It is yours to remove this false impression; to show by practical demonstration that a properly regulated monopoly is the ideal situation in the utility field and that a corporation can be as courteous and as conciliatory as an individual. Friendly relations between the public and the utilities are for these reasons as greatly to be desired as the giving of superlative service and if the Public Service Commission in the administration of its duties can aid in the slightest toward bringing about such proper public relations, its work in that respect will do more toward solving present day utility problems than any other work to which it can set its hands.

CITATIONS QUOTED FROM IN THIS ARTICLE

P. U. R. 1920, B-411 (Arizona).
P. U. R. 1920, B-876 (Michigan).
P. U. R. 1920, B-604 (Missouri).
P. U. R. 1920, A-95 (Nebraska).
P. U. R. 1920, B-199 (Oregon).
P. U. R. 1916, B-442 (Wisconsin).

The Indiana cases quoted from are sufficiently identified by cause number.

Civil Service Examination

The United States Civil Service Commission announces an open competitive examination for laboratorian on June 21 and 22 and Aug. 9 and 10, 1922. Vacancies in the Federal classified service throughout the United States, including the Departmental Service, Washington, D. C., at $1,200 to $1,500 a year, or higher or lower salaries, will be filled from this examination, unless it is found in the interest of the service to fill any vacancy by reinstatement, transfer, or promotion.

The duties of appointees will be to assist in physical and chemical laboratories, prepare solutions, set up chemical and physical apparatus, make repairs, and conduct experimental work, assist in making physical tests, heat treatment, and metallographic examination of metals; determination of transformation temperatures; calibration of instruments, such as pyrometers; calculation and plotting of results of tests; making sketches and drawings of apparatus.

Competitors will be rated on the following subjects, which will have the relative weights indicated:

		Weights.
1.	Mathematics (through trigonometry)	15
2.	Elementary physics	15
3.	Optional subject	30
4.	Education, training and experience	40
	Total	100

The optional subjects are: 1. Chemistry; 2. Physics; 3. Elementary Engineering; and applications must state in which of these the applicant wishes to be examined.

Large Increase in Iron and Steel Production in March.—Because of its fundamental character the iron and steel industry is very often regarded as the barometer of business conditions. The production of both pig iron and steel ingots has been on the increase since last July, but an advance of from 25 to 30 per cent in March, compared to February, marks by far the largest increase for any single month. Pig-iron production of 2,035,000 tons is over 600,000 greater than either the output of the month before or in March last year. This production figure has not been equaled since January, 1921. The prices of iron and steel during March showed little change from February, but this is the first month for a long time that these prices have not shown a decided drop.

Hydro-Electric Installations of Barcelona Traction, Light and Power Co.

By HORACE FIELD PARSHALL

Abstract of a paper read Feb. 7 before Institution of Civil Engineers, London

The more important installations are situated on the Pallaresa River at Talarn and Tremp, at Camarasa, and at Seros on the River Segre, a branch of the River Ebro. The dam at Talarn, like the Camarasa dam, is built on the gravity principle, so that the unbalanced vertical weight component on the upstream face of the dam is equal to the hydrostatic pressure. It is 262 ft. long at the base, 670 ft. long at the crest, 269 ft. high from the main floor to the crest, and approximately 328 ft. from the bottom cut-off wall to the crest, and it impounds about 7,760 million cu. ft. of water.

The Tremp power house, which derives its power from the Talarn dam, is equipped with four 7,000 kw. horizontal type turbo generators, one turbine at each end of the generator. The average annual flow of the River Pallaresa over a period of years is about 49,100 cu. ft., and the output of this power house in normal years is about 110 million kw. hr. At high water level the working head is 249 ft., and at lowest level it is 118 ft. The latter condition, however, has not arisen, the turbines being invariably worked at the higher levels. The general results for the year 1917 show an over-all efficiency of about 72 per cent, or a water consumption of 259 cu. ft. per kw. hr., with a head of 196 to 229 ft. The water utilized in an average year at this power house is 26,593 million cu. ft. The cost of the Talarn and Tremp installation was £1,826,700. The installations at Aytona, or Seros, on the River Segre, of which the rivers Pallaresa and Ribagorzana are tributaries, was the first constructed. The water is taken to the power house by a canal 12 miles in length, while the diversion dam is at Lerida. The power house is designed to accommodate five vertical type generating units of 8,000 kw. (four of which have been installed), and is designed to work with 160 ft. head, the output being in an average year 130 million kw. hr. The cost of this installation is approximately £1,852,260.

The most important and more recent installation described in the paper is that at Casmarasa, sometimes called the "Confluence." The dam at Camarasa is about 105 ft. long at the base, 492 ft. long at the crest, and 318 ft. high from the bottom of the cut-off wall to the footway. It is 246 ft. thick at the base, and contains 280,000 cu. yd. of concrete. A considerable proportion of rock (plums) was used in the dam, the weight of an average plum being 1.18 tons. The spillway was first designed to be an open canal, but subsequent investigation showed it could be more economically constructed. It was designed under Government requirements, to discharge 70,600 cu. ft. of water per second. The water is taken to the power house through a tunnel cut through the rock and lined with cement. This tunnel is 750 sq. ft. in cross-section, 738 ft. in length and has a fall of 8.8 ft., the fall being calculated on the basis that the power plant might be worked at full capacity when the reservoir has been drawn down to a level of 370 ft., corresponding with an effective storage of approximately 1,412 million cu. ft. of water. Very liberal use was made of sand cement for the Camarasa dam, since tests indicated that this material gave an ample factor of safety. The power house at Camarasa, which is built of reinforced concrete, is designed to accommodate five generating units of 12,500 kw. each, two of which have been installed. The capacity of this power house completed will be 182 million kw. hr., and it is designed to utilize the 12 hr. discharge at Tremp in 6 hr., should the demand for power so require. The cost of the Camarasa installation, with two units installed, is approximately £1,370,776. With five units installed the cost will be increased by £375,000, and the capital cost per kw. will be £27.9. The combined output of the Tremp, Camarasa, and Seros installations is approximately 430 million kw. hr., and the nominal horse power is 180,000. The storage capacity of the reservoirs is such that 90 million kw. hr. can be contributed to the combined output of Tremp, Camarasa, and Seros. Results obtained from phase-compensation by means of synchronous condensers are shown in tabular form. This gives the losses before the after phase-compensation, and shows a gross saving of 24,450,000 kw. hr. per annum, and a net saving, after deducting the losses in the condensers and distribution, of 18,950,000 kw. hr. The increased revenue derived from the saving in energy effected augments the possible net income by £80,000 per annum. Preliminary calculations showed that, by the use of synchronous condensers, the power factor could be increased in the ratio of 1 to 1.3, and the terminal voltages increased in the ratio of 1 to 1.2. All predicted advantages have been fully realized in practice. The first transmission lines were equipped with pin type insulators with four petticoats, but these gave a great deal of trouble and were unable to withstand the stress of storms. The line from Seros to Barcelona, which was constructed under the author's direction, is equipped with suspension insulators, seven in series, and has stranded conductors of 250,000 cir. mils section. The line from Camarasa to Igualada has been reconstructed in order to use the suspension type of insulator, and it is equipped with six in series, of the Hewlett type. The standards are designed for straight runs with average spans of 650 ft. They are equipped with two lightning guard wires of ⅜ in. diameter, and are designed to withstand a wind pressure due to a velocity of 100 miles per hour with ½ in. of sleet on wires, the towers to remain stable with two wires broken.

State Reciprocity for Licensed Engineers

What Is Being Done to Secure Reciprocal Registration, Outlined in Paper Presented at A. A. E. Conference of Practicing Engineers

By C. S. HAMMATT,

Secretary Florida State Board of Examiners and President National Council of State Boards of Engineering Examiners.

State reciprocity for the practicing engineers with licensing does not exist at the present time, although the various states in passing their registration laws have aimed to provide for it. Every state has legislated differently in the matter of registration, yet they assert that reciprocity for engineers is to be effective providing the standard is not lower in the other states than those specified in their acts. Such a provision is not practically in force, even in those ten states which have become members of the National Council of State Boards of Engineering Examiners, although they aim to make it effective, and such a condition cannot exist, in point of fact, until such time as the Council of the State Boards of Engineering Examiners can agree upon a uniform standard of requirements, which as yet has not been done. After such standard has been agreed upon those states which adopt that standard for "Reciprocal Registration" by resolution of their boards may reap the benefit of the intention of the laws. We will then have two classifications of registered engineers: Those who practice within their own states and those who can practice in any state, upon paying the fee and filing their papers. This may be accomplished, without changing the law of any of the states, through the Council of State Boards of Engineering Examiners.

Reciprocity between the states covering the practice of registering professional engineers is interpreted as "equal mutual rights granted and enjoyed" according to the definition of the word, which was officially coined in 1782 in the Provisional Treaty between England and the United States, the paternity of the word lying between Blackstone and Lord Shelbourne. Inasmuch as all the states have different laws, it is somewhat difficult to see how the several state boards of engineering examiners can function this clause for reciprocity without some change in the laws upon a uniform basis, or by an interpretation guided by a standard agreed to by the several boards.

The problems thus confronting the boards resulted in the organization of the council of state boards of engineering examiners, in the hope that this central or national council would be able to unify a procedure that would accomplish the aim of the several laws which provide for reciprocal relation, which is "mutual, interchangeable, convertible qualification," such that one may be accepted as the equivalent of the other in the different states.

It will be readily appreciated as a hopeless task to accomplish the passing of a uniform code by the several state legislatures, but as the standard of requirement for registration is left largely to the discretion of the several boards, it would seem perfectly feasible for these boards to unite upon a common level and provide for a standard that would be acceptable to all for the reciprocal interchange of registration.

Inasmuch, however, as various states must provide for registering professional engineers with less qualification than that which might be prescribed by the council, these boards could issue their certificates to conform with their laws without the seal of approval of reciprocity.

In the passing of the engineers' registration law the several state legislatures have been compelled to provide for the "waiver" or "grandfather" clause, together with various qualifications and requirements which may in large measure apply to their state jurisdiction and therefore would not become incumbent upon another state. It follows that a qualification for reciprocal registration that would be accepted by all the states must of necessity start off with a standard as high as that prescribed by the most exacting of all the laws, and it should be such as would command the respect and approval of all skilled and educated men in the profession. To bring this about appears to be an easy matter, through the Council of State Boards of Engineering Examiners. The council is composed of a representative from the several state boards and they can provide a uniform code which, if agreed to by the various state boards by resolution, can become operative by the attachment to certificates issued by the state boards of an additional seal bearing the words, "Reciprocal Registration," for such engineers as may be worthy of recognition by other states under the standard qualifications.

This will nowise conflict with the local state laws, but will be an additional functioning on the part of the boards, whereby they give to all other states the assurance of the worthiness of recognition wherever the certificates may be presented. This additional seal should be attached to all certificates or renewal certificates of those who are qualified under the uniform code, and all certificates not bearing this seal would become qualifying only in the state issuing same. Every state board, upon request, would then issue to such states as the applicant may desire, a statement certifying under seal that the engineer in question had been issued a "reciprocal certificate." This statement could then be filed with the engineer's application for registration upon the regular forms of said state, filling in all data required, together with the fee, and not requiring the personal appearance of the applicant before said board. The state board applied to would then issue a certificate without further delay or process.

While some states require but two, four or six years' experience, others exact ten years. The uniform code should call for the maximum time exacted by any of the states and should commence the calculation of that period with duties above those of apprenticeship, foremanship or inspector, and with those of civil engineers whose experience is not less than that of actual instrumentman, unless such duties were shown to be of a very responsible character. The character of work performed, under what authority vested, for whom and when, in the statement of experience should be carefully scrutinized and only such credit given for reciprocal registration as would be, beyond question, fully qualifying, thus providing requirements of sufficiently high character and reliability that no question might be raised as to the integrity of the statement. It would seem that the operation under this provision would be very simple and effective insofar as a man was fully qualified. Those who could qualify only under a lower classification would still practice within their own state, if complying with their home laws.

The operation of the registration law for registered engineers has largely proved a great benefit to those engaged in the profession as well as a protection for the public, and there seems but little doubt that every state in the Union will eventually adopt a law covering this protection in one form or another.

The National Council of State Boards of Engineering Examiners in October next will no doubt provide for some basis as outlined above whereby the various state boards can increase confidence in each other and issue certificates upon the same application to those engineers coming from other states whose boards have put their stamp of approval upon these qualifications based on a uniform standard.

The Academic Mind.

By P. B. McDONALD.
Assistant Professor of English, College of Engineering, New York University

Many examples of the academic mind are met outside universities. Clergymen, publicists, statesmen, engineers, journalists—all are liable to think in the systematic but rather narrow manner that we style academic. The United States is said to have more of the excessively academic spirit than, say, England; it strongly influences our social customs, our culture, our literary criticism, and even our laws. Perhaps the large proportion of it in America is a reaction from our other extreme, Yankee practicality; Americans tend toward extremes.

The president of the University of Michigan in a recent address explained that students coming to college are puzzled by the presence upon the campus of the academic mind. For such a mind is a puzzling and curious phenomenon. In many respects it is restricted and difficult, but it possesses virtues that have had, and still are having, profoundly beneficial effects upon history. For instance, Woodrow Wilson's is a modified type of academic mind; he was able to think historically and plan in a detached way because of his academic training. Eamon de Valera, a typical example of the academic mind, successfully led hot-headed, diverse-thinking Irish rebels through several years of difficult undertakings when a less steadfast or less dignified leader would have spoiled the show a dozen times.

H. G. Wells, as might be expected, has little use for the academic mind. He describes the appearance of the type at the Alexandrian Museum in the first centuries of the Christian era. In Wells' penetrating words, it was "a specialized queer class with unpleasant characteristics—shy, eccentric, unpractical, incapable of essentials, strangely fierce upon trivialities of literary detail, as bitterly jealous of the colleague within as of the unlearned without, the bent scholarly man." And Wells continues. "He was as intolerant as a priest, though he had no altar; as obscurantist as a magician, though he had no cave."

Though Wells' criticism is more or less true, it is necessary to take the bad with the good. Human nature of any pronounced type exhibits the defects of its virtues. However, the academic mind did not originate at the Alexandria Museum (which was, by the way, the world's first college of science, where studied Euclid, Archimedes, Galen, Ptolemy, and many other famous men). Egypt had been producing academic minds for thousands of years in its hierarchy of priests. Athens had produced the type before Alexandria was founded. One of the best examples of the academic mind was the great Aristotle himself, "the master of those who know."

Aristotle was the professor de luxe. He methodized and subdivided, and theorized and dogmatized, to a degree that perhaps has never been equaled. With the patronage of his former pupil, Alexander the Great, he collected specimens and information from diverse sources and founded zoology; he wrote on animals, on physics, on metaphysics, on astronomy, on ethics, on politics, on rhetoric, and on poetry. As proof of his dogmatic style note the following quotation from his writings: "The flesh of all quadrupeds which feed in marshy grounds is inferior to that of those which live on high ground. Sheep with wide tails endure the winter better than those with long tails, and short wooled sheep better than long-wooled, and those with curly hair are more affected by the cold. . . . For the birds with crooked claws, generally speaking, as it was before remarked, do not drink."

Aristotle declared that "three" is the most perfect number because "it is the first of numbers, for of 'one' we do not speak as a number, of 'two' we say 'both,' 'three' is the first number of which we say 'all.'" Incidentally the question whether "one" is a number or not was debated long and strenuously by the academic minded of past centuries.

The academic mind, then, is dogmatic, abstruse and jealous over trifles; but it is also cool, systematic and historically poised. Possibly the world would benefit more from the universities if the professors would develop a sense of proportion and learn to express their ideas in more intelligible and attractive form. But as the distinguished president of Amherst College has pointed out, the world is indebted tremendously to the societies of scholars who live somewhat apart from the hurly-burly of markets and shops; and on innumerable occasions the academic mind has supplied exactly the quality needed for important results.

The Computation of the Practicing Engineers' Income Tax

The computation of the Federal Income Tax of anyone so fortunate as to have an income large enough to tax, is at best a somewhat complicated mathematical problem which usually taxes one's ability to figure as well as one's income. In the case of the practicing engineer, the problem is further complicated by the provision of the law which exempts from taxation "Compensation paid by State or political subdivisions thereof to its officers or employees." Some interesting points on this particular feature were brought out by Mr. Clarence W. Hubbell, City Engineer of Detroit, Mich., in a paper presented Feb. 22 at the American Association of Engineers' Conference of Practicing Engineers. We quote from the paper as follows:

A considerable proportion of the work done by the practicing engineer is in connection with municipal improvements, and as municipalities are recognized as political subdivisions of a state it would seem that compensation received for such work would be exempt from taxation by the exemp- for such work would be exempt from taxature by the exemption clause above noted. The term "compensation" is broad enough to include wages, salaries, retaining fees, lump sum fees per diem, or fees paid on a percentage basis. All of the usual methods employed by practicing engineers in charging for professional services, are undoubtedly covered by the term "Compensation." The term is indeed so broad that contractors have claimed exemption on the basis that "compensation" paid them by a state or political subdivision thereof was not subject to income tax.

But note that the exemption covers only "Compensation paid to officers or employees." The whole question so far as engineers are concerned, then depends upon the determination of his status as an officer or employee, and whether or not his method of charging for his service determines that status. In other words, would an engineer receiving a salary be an "employee" and the same engineer performing exactly the same work for a percentage fee be classed as a "contractor?"

In the early days some members of the profession upon inquiry were instructed that a very broad interpretation would be given to this provision of the law, and that fees received by engineers from municipalities were not subject to tax. The instructions have not been uniform in the different collection districts or even at different times in the same district. Some engineers who have been advised by agents of the Treasury not to include certain items in their returns have afterward been asked to pay taxes on them. In other cases money has been returned. In fact, the rulings on record are erratic and impossible to harmonize. A few examples are here given:

Fees of notaries and receivers	Not taxable
Fees of witnesses called by state	Taxable
Per diem pay of county surveyor	Not taxable
Consulting engineer (2 years) state irrigation	Taxable
Attorney fees for collecting state inheritance tax	Not taxable
Salary (hourly rate) consolidating state laws	Taxable

Tests of Absorption of Hollow Tile

The porosity of clay products has an important bearing on their strength and fire-resisting properties as well as upon their ability to withstand repetitions of freezing and thawing. The percentage of water absorbed under given conditions can be taken as an index of the porosity of clay bodies burnt below vitrification. Until recently building ordinances generally prescribed immersion in cold water for two or three days as the method for determining porosity, but lately there has been a general change to the five-hour boiling method, often without a change in the specified absorption limits.

An investigation has been conducted by the U. S. Bureau of Standards to determine the diffrence in results obtained with various methods and their effectiveness in determining the total porosity. Specimens of the different types of clay were successively immersed in water for periods up to nine days and in boiling water for periods up to five hours with determination of rates of absorption. Similar determinations were made under vacuum and finally the total porosity was obtained by volume and specific gravity measurements.

The results, while varying considerably between different types of clay, are in general: (1) Absorption determined by cold water immersion does not approach near enough to complete saturation to give practical and consistent results; (2) the best practical method consists in boiling for five hours, cooling the water and specimens to room temperature, and allowing them to soak for one hour. When about 88 per cent saturation is reached, the absorption thus determined is on the average 1.28 times that determined by immersion in cold water for 72 hours. (3) Proper treatment under vacuum will give nearly the full saturation and porosity, but the method is probably too complicated for use in acceptance tests.

A Peculiar Obstruction in Mains.—Three galvanized iron buckets brought Santa Barbara, Calif., up against a water famine for several days, one reservoir drying up and another almost reaching the exhaustion point. Alarmed over the situation, city officials started an investigation and after carrying on pressure tests located the trouble in an eighteen-inch main. There they found the three buckets which in some manner had gotten into the pipe and after circulating about for months lodged against a gate valve shutting off the flow.

The buckets had been left in a water tower eighteen months ago. During the time they were lodged against the valve water in the city's mains had lost 50 per cent of normal pressure and the city was menaced, say officials.

Daylight Saving.—Indianapolis Chapter, American Association of Engineers, endorsed daylight saving at a meeting in April.

American Waterworks Association Convention

Philadelphia May 15-19, 1922

Headquarters at Bellevue-Stratford Hotel.

Daylight saving time used.

All sessions are to be called promptly on time, as this is the only way in which the program can be completed.

Monday, May 15.—Morning session, improved group meetings for all interested.

1. Office Records, Methods, Accounts, etc.
2. Pumping Station, Engines, Boilers, Firing, etc.
3. Filter Plant, Operation, Care, etc.
4. Pipe Laying, Methods, Records, etc.
5. Services and Meters, Material of Services, Laying, Meter Setting, Reading and Care.
6. Water Sheds and Reservoirs, Care, Algae Treatment, Tree Planting, etc.
7. Private Fire Protection Services. Especially inter-connection with polluted sources and the efficiency of double check valves on such services.

2:00 P. M. Executive Committee and standing committees.
8:00 P. M. President's address.
8:30 P. M. Reception and dance.

Tuesday, May 16.—9:00 A. M. Opening of convention.

Philadelphia Water Supply, Present and Proposed, by George W. Fuller.

Fire Prevention and Fire Protection in Relation to Water Supply, by Frank C. Jordan.

12:00 M. Election of members of Nominating Committee.
1:30 P. M. Ladies' trip to Valley Forge by special conveyance. Returning, reach hotel by 5 p. m.
2:00 P. M. Development of the Schoharie Water Shed, Catskill Water Supply, by J. Waldo Smith.
The Hetch Hetchy Water Supply, by M. M. O'Shaughnessy.
The Construction of the Loch Raven Dam, by Wm. A. Megraw.
Twenty Years' Filtration Practice at Albany, N. Y., by G. E. Willcomb.
8:00 P. M. Water Works Manufacturers' Association Program.
Moving pictures showing 20,000 H.P. of high steam pressure being discharged to atmosphere and shut off in 30 seconds. Description by Peter Payne Dean.
Underground Leakage and Its Relation to Mains and Services, by Thomas F. Wolfe.
Pneumatic Pumping, Up-to-Date, by John Oliphant.

Wednesday, May 17. 9:00 A. M. Reports of special committees.
Standard Form of Contract, by J. Waldo Smith, Chairman.
Standardization Council, by George W. Fuller, Chairman.
Industrial Wastes in Relation to Water Supply, by Almon A. Fales, Chairman.
Water Shed Protection, by Theodore DeL. Coffin, Chairman.
Problems in the Reforestation of Water Sheds, by George R. Taylor.
Selection of Place for Holding the 1923 Convention.
[illegible] P. M.—Afternoon. Trip by Delaware River boat to Wilmington and return.
[illegible] P. M. Some Observations Concerning Wood Pipe, by J. W. Ledoux.
Report of Committee on Standard Specifications for Cast Iron Pipe and Specials, by F. A. Barbour, Chairman.
Experience with Cast Iron Water Pipe for Pressures Higher than Allowed by Current Specifications, by C. E. Inman.
Centrifugally Cast Iron Pipe, by Peter Gillespie.
For the Ladies.—Theater party. Tickets for reserved seats will be distributed by the chairman of the Ladies' Entertainment Committee.

Thursday, May 18.—9:00 A. M. Superintendents' Day.
Water Chlorination Control in Virginia, by L. N. Enslow.
Practical Demonstration of Control Test.
Report of Committee on Physical Standards for Distribution Systems, by G. Gale Dixon, Chairman.
Air and Relief Valves, by M. M. Borden.
Instances of the Value of a Sanitary Survey, by W. P. Mason.
Causes of Failure of Cast Iron Pipe, by F. A. McInnes.
Topical Discussion of Breaks in Water Mains and on General Subjects.
Refer to list of topics in circular to Superintendents.
2:00 P. M. Equipment and Shop Facilities for Maintenance of Water Works Systems, by George E. Cripps.
Topical Discussions.
Present Day Tars for Pipe Coatings, by W. R. Conard.
Topical Discussions.
See page 14 for Chemical and Bacteriological Section Program.
Chemical and Bacteriological Section Separate Meeting.
For the Ladies.—Shopping trips, visits to Independence Hall and other points of interest under direction of Ladies' Entertainment Committee.
8:00 P. M. Purification of Water for Industrial Uses, by S. T. Powell.
Lime, Soda and Zeolite Water Softening, by A. S. Behrman.
Tubo-Centrifugal Pumps, by Richard Waller.
Entertainment for the Ladies.—Card party mezzanine floor of the Bellevue-Stratford Hotel.
[illegible] P. M. For the Men. Smoker.

Friday, May 19, 1922. 9:00 A. M. Joint Session with Chemical and Bacteriological Section.
Plant Control of Chlorination by the Excess Chlorine Method as Employed on New York City's Water Supplies, by Frank E. Hale.
Responsibility of the Water Works Superintendent to Prevent Tastes and Odors Due to Microscopic Organisms, by Wm. W. Brush.
Further Notes on Chlorine Control at Grand Rapids, by W. A. Sperry.
Recent Practice in the Removal of Odors by Aeration, Filtration and Other Processes, by Norman J. Howard.
Recent Developments in Chlorination, by Wm. J. Orchard.
2:00 P. M. Report of Committee on Meter Schedules, by Allen Hazen, Chairman.
Steel Pipe, by Theodore A. Leisen.
Steel Pipe, by G. A. Elliott.
Design, Construction and Operation of a Balance Reservoir, by Wm. A. Megraw.
Chemical and Bacteriological Section—Separate Meeting.

National Highway Traffic Association to Meet May 12

The 1922 annual meeting of the National Highway Traffic Association will be held May 12 in the Assembly Hall of the Automobile Club of America, 247 West 54th St., New York City. Sessions will be held at 2:00 and at 8:00 p. m., and dinner will be served in the club rooms at 6:00.

In addition to regular meetings, committee reports, etc., papers will be presented upon the following subjects:

Uniform Highway Signs.
Traffic Capacity and Widths of Highways Outside of Municipalities.
Status of the Construction of Highway Curves and Recommended Practice to Increase Safety to Traffic.
Highway Improvement Creed.
The Railroad as an Operator of Highway Transport.
Regulations Covering Speeds, Weights and Dimensions of Motor Trucks and Trailers.
License Fees and Motor Vehicle Taxation.
Highway Transport Franchises.
Highway Transport Clearing Houses.

American Road Builders Meeting, May 15

The annual meeting of the American Road Builders' Association will be held at The Automobile Club of America, 247 West 54th street, New York City, on May 15. The program is outlined as follows:

10 a. m.—Meeting, board of directors.
3 p. m.—Meeting of the members of the association.
Reports of officers.
Discussions.
6 p. m.—Recess.
6:30 p. m.—Annual "get-together" dinner in the grill room of the Automobile Club of America, $2 per plate.
8:30 p. m.—Report of tellers.
Address of retiring president.
Address of new president.
Unfinished business.
Adjournment.

Personals

E. R. Thomas is now city engineer of Victoria, Tex. He was formerly city engineer of Port Arthur, Tex.

J. P. Manning, of Nowata, Okla., has accepted the position of city manager of Sapulpa, Okla., at a salary of $400 per month.

Henry S. Charron has been appointed superintendent of the water department of Burlington, Vt., to succeed J. Frank Kidder.

Thomas Williamson, well known farmer and irrigation engineer of Nevada, will become construction engineer for a 50,000-acre irrigation project in the wheat belt of Canada.

James E. Smith of St. Louis was elected president of the Mississippi Valley Association at the annual meeting held at Kansas City on April 26. Mr. Smith has been a leader in navigation in the Mississippi Valley for nearly [illegible] years.

Nebeker, Jenson, Wood & Co. is the name of a newly organized firm of engineers and contractors at Salt Lake City. The three principals are all well known in Salt Lake. Mr. Jenson is a graduate of Massachusetts Institute of Technology.

V. A. Thompson, City Manager, and **L. B. Hitchcock**, City Engineer of Phoenix, Ariz., both resigned their positions late in April. Newspaper reports indicate that dissatisfaction with political interference was the cause of the resignations. Mr. Thompson plans to enter a general contracting and engineering business. Mr. Hitchcock's plans are not announced.

Obituaries

F. J. Reckwerth, 61 years old, for [illegible] years a contractor in Houston, Tex., died suddenly on April [illegible] at his home in Houston.

Alfred Clarke, widely known [illegible] inventor and mechanical engineer, died at his home in [illegible], N. H., on April [illegible], at the age of [illegible]. He was engaged at different times in many important engineering and related activities.

Ralph E. Thompson, engineer in charge of the construction of the Black Canyon dam near Emmett, Idaho, for the United States Reclamation Service, was drowned in the Payette river April 20 when, with a workman, he attempted to cross the river in a skiff, which was overturned by an eddy of the rushing current.

SOURCES OF INFORMATION
ON
Equipment, Machinery and Materials

The catalogs and other publications of this list contain useful information, and unless otherwise noted, may be obtained free upon application. The list will be kept up to date and enlarged as new catalogs and bulletins replace existing ones and additional publications are received at this office.

CAST IRON PIPE DATA

The Cast Iron Pipe Publicity Bureau, Erie and St. Clair Sts., Chicago, representing numerous manufacturers, will furnish very full information and references on request. Its cloth bound book, "Pipe and the Public Welfare," is sold for 25c postpaid.

STEEL PIPE FOR SPECIAL USES.

Pipe for dredging, mine ventilation, surface irrigation, well casing, gravity drainage, etc., made in various gauges and lengths, is described in the literature of Robertson Brothers Manufacturing Co., 1036 W. 37th St., Chicago.

SPECIFICATIONS, DIMENSIONS, THICKNESSES AND WEIGHTS OF SOIL PIPE AND FITTINGS

These data are published in compact and useful form in the catalog of the Central Foundry Company, 90 West St., New York. They cover a very wide range of sizes and types of fittings.

WOOD STAVE PIPE

The catalog entitled "Pacific Wood Stave Pipe," issued by the Pacific Tank & Pipe Co., of San Francisco, not only describes the products manufactured by that company but contains an extensive set of hydraulic tables.

CREOSOTED WOOD PIPE

Uses and manufacture of creosoted wood pipe are described and data are given in Catalog No. 17 of the Continental Pipe Mfg. Co., Seattle, Wash.

CALIFORNIA REDWOOD

The Pacific Lumber Company, 2076 McCormick Bldg., Chicago, issues catalogs giving the characteristics and uses of this well known Pacific Coast timber.

REINFORCED CONCRETE PIPE

Pipe ranging from 24 to 96 inches diameter is described and specifications are given in the catalog of the Independent Concrete Pipe Company, 201 N. West St., Indianapolis, Ind.

LOCK JOINT REINFORCED CONCRETE PIPE

This pipe is described with many illustrations and detail drawings in the catalog of the Lock Joint Pipe Company, Ampere, N. J.

PIPE FITTINGS

Catalog No. 42-A of the Kennedy Valve Manufacturing Company, Elmira, N. Y., tabulates many classes of cast and malleable iron fittings in a large variety of sizes.

VALVES OF ALL CLASSES

Extensive statistical data on a great variety of valves is published in the catalog and price list of the Kennedy Valve Manufacturing Company, Elmira, N. Y.

REDUCING VALVES

A small hand book issued by the Atlas Valve Company, Newark, N. J., gives tables and rules for determining capacity of reducing valves and pipe connections.

VALVES AND FIRE HYDRANTS

Profusely illustrated catalogs issued by the Kennedy Valve Manufacturing Company, Elmira, N. Y., describe the many types of valves and hydrants made by them.

HYDRANTS AND VALVES.

Full information on Mathews hydrants, valves, cast iron pipe and other equipment will be furnished on request by R. D. Wood & Co., Philadelphia.

DRILLING MACHINES

Catalog 145 of the American Well Works, Aurora, Illinois, describes in detail equipment for the drilling of wells, deep blast holes and prospecting, and includes a complete list of drilling tools.

PIPE CUTTING AND THREADING MACHINES

Six types of machines are described and illustrated in the catalog entitled, "Stoever Pipe Machine," issued by Treadwell Engineering Co., Easton, Pa.

CLEANING WATER MAINS

The National Water Main Cleaning Company, 30 Church St., New York City, issues a twenty-two page booklet describing causes of dirty mains and methods of cleaning them. It also gives a table of work done, showing size and length of main and discharges before and after cleaning and other descriptive data on each case.

BRONZE PRODUCTS FOR ENGINEERING REQUIREMENTS

Bronze rods, valves, turbine parts, gears, etc., as well as castings, forgings, sheets and shapes are described in the catalog of the American Manganese Bronze Company, Holmsburg, Philadelphia, Pa.

METER BOXES

H. W. Clark Co., 12th and Hudson Ave., Mattoon, Ill., issues a catalog fully describing its line of frost-tight boxes.

METER BOXES

The Ford Meter Box Co., Wabash, Indiana, makes a variety of boxes, and will send full information upon request.

WATER METERS

Descriptive matter on water meters and their use will be furnished upon application by the Gamon Meter Co., 282 South St., Newark, N. J.

WATER METERS FOR EVERY SERVICE

The Badger Meter Manufacturing Company, 811 30th St., Milwaukee, Wis., issues circulars giving descriptions and tabulated data on many classes of water meters.

METERS FOR VARIOUS USES

The Hersey Manufacturing Co., 314 W. 2nd St., Boston, Mass., makes a variety of meters on which it will send full literature upon request.

WATER METERS AND WATER WASTE SURVEYS

Literature issued by the Simplex Valve & Meter Company, 5722 Race St., Philadelphia, Pa., describes many different sorts of meters and their uses. Bulletin No. 30 gives detailed information on the making of water waste surveys and the equipment used therein.

WATER METERS

The Pittsburgh Meter Co., East Pittsburgh, Pa., makes a variety of meters upon which it will gladly furnish full information.

METER FACTS AND FIGURES

The uses of Meters and the savings effected thereby, as well as the meters themselves, are described in publications of the Neptune Meter Co., New York City.

METERS FOR EVERY TYPE OF SERVICE

Full information on disc, current and compound meters, including details of construction, will be furnished on request by the Thomson Meter Co., 100-110 Bridge St., Brooklyn, N. Y., makers of "Lambert Meters."

STANDARD WATER METERS

The Buffalo Meter Co., 2909 Main St., Buffalo, New York, will furnish catalog and price list giving full account of "American Water Meters." These meters are designed to meet fully the specifications of the American Waterworks Association.

WATER METERS

Information on a complete line of water meters is contained in the publication of the Union Water Meter Co., 38 Herman St., Worcester, Mass.

WATER CONTROL INDICATORS

Indicators for showing valve and head conditions, at remote points, and the uses of such indicators, are described in Bulletin No. 43-A of Payne-Dean, Ltd., 103 Park Ave., New York City.

CHLORINE CONTROL APPARATUS

This is the title of an extensive illustrated catalog issued by Wallace & Tiernan Company, 466 Peoples Gas Bldg., Chicago. Both water purification and sewage treatment are explained and diagrams and plans are furnished.

HYDROGEN-ION TESTING SET

The LaMotte Chemical Products Co., 113 W. Saratoga St., Baltimore, Md., has just issued a booklet describing equipment and procedure for the chlorimetric study of hydrogen-ion concentration.

SANITATION OF SWIMMING POOLS

"Pure Water for Swimming Pools" is the title of Technical Publication No. 21, issued by Wallace & Tiernan Company, 466 Peoples Gas Bldg., Chicago. This treats of the equipment and the procedure of purifying swimming pools by chlorination.

TECHNICAL BOOKS

The McGraw-Hill Company's 1922 catalog contains a classified list of high grade texts on practically all phases of engineering. The catalog may be obtained from McGraw-Hill Book Co., 370 Seventh Ave., New York City.

CENTRIFUGAL PUMPS

Bulletin W-605 of the Worthington Pump & Machinery Corporation, 115 Broadway, New York, not only describes a variety of types and sizes of pumps, but furnishes a large amount of useful information, such as capacity, speed and efficiency diagrams, and operating data.

STEAM TURBINES AND CENTRIFUGAL PUMPS

Very complete information on these machines is given in the various catalogs of the [illegible] Steam Turbine Company, [illegible]. There are separate catalogs on [illegible] and [illegible] centrifugal pumps.

PUMPS FOR EVERY SERVICE

The Goulds Manufacturing Company, Seneca Falls, New York, makes both hand and power pumps for every purpose, and is now issuing twenty bulletins, each of them giving complete information on the various types of [illegible], for example, [illegible] and [illegible] pumps, single acting triplex [illegible] pumps, and centrifugal power pumps. The bulletins also contain very [illegible] tables.

CENTRIFUGAL PUMPS

Many sizes of centrifugal pumps, with rated capacities from 50 to 1,000 gallons per minute, are described in the catalog of the [illegible] Co., 127 York St., Quincy, Ill., Bulletin No. 218. The bulletin is illustrated and gives a considerable amount of descriptive matter, including diagrams and tables.

STEAM PUMPS IN TEN SIZES

The catalog of the Emerson Pump & Valve Company, Alexandria, Va., gives a detailed account of the pumps made by this company. Capacities, weights, prices and other data are given in tabular form.

PUMPS AND ACCESSORIES

Catalog No. 26 of A. D. Cook, manufacturer, Lawrenceburg, Ind., gives illustrations, diagrams, prices and statistical data on a large variety of steam, belt and motor driven well pumps and of pump parts, well tubing and supplies.

AIRLIFT PUMPING

Equipment and methods for this class of pumping are described in detail in Bulletin No. 71 of the Sullivan Machinery Company, 130 So. Michigan Ave., Chicago. Other bulletins of this company give extensive accounts of stationary and portable air compressors and engines, vacuum pumps, air drills, etc.

POWER PUMPS

Portable and stationary pumps of centrifugal, diaphragm and triplex types are described and specifications given in Bulletin No. [illegible] of the C. H. & E. Manufacturing Company, 254 Mineral St., Milwaukee, Wisconsin.

PUMPING EQUIPMENT OF ALL KINDS

Numerous bulletins and catalogs of the American Well Works, Aurora, Illinois, describe in detail and furnish tabulated statistical data on the great variety of pumps, pump parts and accessory equipment made by this company. Requests for publications should specify the purpose for which equipment is desired.

PUMPING MACHINERY

Bulletins of the John H. McGowan Company, Cincinnati, Ohio, give full details on different types of steam and power pumps, together with several pages of engineering [illegible].

STEAM PUMPS FOR ROUGH WORK

The [illegible] Steam Pump Co., 222 West 42nd St., New York City, will furnish information on pumps especially designed to handle sand, rocks and gravel and for [illegible] other conditions.

DISTILLED BOILER WATER

Self-cleaning evaporators for the production of [illegible] water are described in Bulletin No. [illegible] of the Griscom-Russell Co., 90 West St., New York City. The catalog describes the equipment and its operation [illegible] tabulated items.

WATER AND OIL HEATERS

Heaters for [illegible] hot water, [illegible] the catalogs and publications of the [illegible] Motor Company, 200 [illegible], New York.

GENERAL UTILITY ENGINES

The Fuller & Johnson Manufacturing Company, [illegible] St., Madison, Wis., publishes [illegible] a variety of pumping and [illegible].

AIR DRILLS AND COMPRESSORS

[illegible] Sullivan Machinery Company, [illegible] Michigan Ave., Chicago, [illegible] of the [illegible] airlift pumps [illegible] etc.

BLOWERS AND REPAIR EQUIPMENT OF ALL CLASSES.

[illegible] Company, [illegible] a large [illegible] equipment, [illegible].

PNEUMATIC TOOLS, DRILLS, AIR COMPRESSORS AND ELECTRIC TOOLS

Bulletins of the Chicago Pneumatic Tool Company, Pneumatic Building, Chicago, Ill., give very detailed accounts of the above classes of equipment and include tabulated data on each.

PORTABLE AIR COMPRESSORS

The catalog of the Mundie Manufacturing Company, Peru, Illinois, gives data on ten sizes of portable compressors bearing the trade name "Zan Ho."

PUMPING AND LIGHT PORTABLE ENGINES.

Catalogs of the Fuller & Johnson Manufacturing Company, 10 Elm St., Madison, Wisconsin, describe an extensive line of light gasoline and oil engines.

HORIZONTAL OIL ENGINES

Single cylinder single acting oil engines in which fuel injection and complete atomization are obtained without the use of high pressure air are described in Bulletin No. [illegible] of the Ingersoll Rand Co., 11 Broadway, New York, issued in March, 1922. The catalog describes various advantages claimed for these engines and is illustrated with cuts and diagrams.

GASOLINE LOCOMOTIVES FOR ALL PURPOSES

The Fate-Root-Heath Company, 265 Riggs Ave., Plymouth, Ohio, issues a series of bulletins describing in detail its gasoline locomotives. These bulletins will be sent to persons stating their requirements. One of the papers is devoted entirely to the use of gasoline locomotives on highway construction.

GASOLINE LOCOMOTIVES

Numerous types and details of gasoline locomotives for industrial and other uses are pictured and described in publication No. 118 of the Milwaukee Locomotive Mfg. Co., Milwaukee, Wis.

STORAGE BATTERY LOCOMOTIVES

Electric battery locomotives for mine and industrial use are described in Bulletin No. 102 of the Ironton Co., Ironton, O.

CRAWLER AND WHEEL TYPE LOCOMOTIVE CRANES

Seven- and 12-ton cranes in the above types are described in Catalog No. 21 of Orton & Steinbrenner Co., Chicago, Ill. The catalog is illustrated and provided with data.

LOCOMOTIVE CRANES AND RAILROAD DITCHERS

Separate catalogs of the American Hoist & Derrick Co., St. Paul, Minn., describe these machines and other equipment.

HOISTS AND DERRICKS FOR CONTRACTORS AND BUILDERS

Bulletin H. D. 501, issued by Pawling & Harnischfeger Co., 3800 National Ave., Milwaukee, Wis., describes hoists and derricks and is well supplied with illustrations and tabular data.

TRENCH EXCAVATORS FOR VERTICAL OR SLOPING SIDES

Excavators of both the wheel and ladder types are described in the catalog of the Buckeye Traction Ditcher Company, Findlay, Ohio. The catalog is in great detail and with many illustrations. Among other data it gives costs of operation. In addition to the trenchers, pipe laying and other special machines are described.

EXCAVATORS AND BACKFILLERS

Literature on a large variety of these machines is furnished by the Parsons Company, Newton, Iowa.

BOOM DREDGES AND CRANES

The Bay City Dredge Works, 2611 Center Ave., Bay City, Michigan, issues a catalog describing in detail, with diagrams and tables, the various types of equipment manufactured by it. These include crawling, walking, track and floating dredges, a cheaper excavator for clay, sand and gravel pits, and other items of earth handling equipment.

GRAB BUCKETS

Catalogs Nos. 44 and 45 of the Hayward Company, 50 Church St., New York, respectively describe buckets for industrial [illegible] and special electric motor buckets. They give diagrams of layouts, tables of [illegible] and working data, etc.

TRUCKS FOR USE ON SUBGRADE

"Titan Subgrade Trucks" is the title of a catalog just issued by the Titan Truck Co., of Milwaukee, Wis. This catalog describes with numerous illustrations a variety of trucks for batch hauling, wet mix, asphalt, concrete, [illegible], etc.

AUTOMATIC DUMP BODIES

The American Promotion and Trading Company, 1507 So. Morgan St., Chicago, issues an illustrated circular on several sizes and types of rolling dump bodies for trucks. Other contractors' equipment, including wooden and steel batch boxes, concrete buggies and trucks, are included in the circular. A complete catalog will be furnished on request.

DUMP BODIES, TANKS AND HOISTS.

Catalog No. 120 of the Heil Company, 1138-50 Montana Ave., Milwaukee, describes a large variety of body equipment and special features. There are many illustrations.

WHEEL SCRAPERS

Smith & Sons Manufacturing Co., 504 Gunnette Ave., Kansas City, Mo. Catalog of "Raytrac" all steel multi-unit wheel scrapers. Describes equipment and improvements, gives instructions for operation and shows tabulated cost data under varying conditions of haul, etc. Actual test data and maintenance costs are given.

LEANING WHEEL GRADERS AND ATTACHMENTS

Illustrated catalogs issued by J. D. Adams & Co., Indianapolis, Ind., describe a wide variety of graders, back sloper attachments and other grading equipment.

COMPLETE CRUSHED STONE OUTFITS

Stationary and jaw crushers, rotary pulverizers, screens, bins and elevators in numerous sizes are described in the folder issued by the Universal Crusher Company, 224 3rd St., Cedar Rapids, Iowa. Portable outfits are provided complete with power crushers, elevators, screens and bins. Dimensions and weights of the various units are given.

DITCHING WITH DYNAMITE

The above is the title of a booklet describing the use of dynamite in drainage work, and giving many examples, issued by the E. I. du Pont de Nemours & Co., Wilmington, Del.

EXPLOSIVES AND BLASTING EQUIPMENT

Explosives for all purposes and a great variety of equipment, such as detonators and boring machines, etc., are described in a series of catalogs issued by the Hercules Powder Company, 943 King St., Wilmington, Delaware. There are separate publications describing the products of the company, the use of explosives in road building and maintenance, their uses in mining and in land development, including stump-blasting, ditching, etc.

THE USES OF GUNITE

A great variety of uses of Gunite are described in Gunite Book No. 7, just issued by the Cement-Gun Construction Co., of Chicago.

CEMENT BAG CLEANERS AND BALERS

The Hardy Sack Baler Company, Cedar Rapids, Iowa, issues illustrated folders describing the cleaning and baling machines made by it. There are five sizes of cleaners with capacities ranging from 150 to 1200 per hour. There is also a list of firms using these machines.

PORTABLE SAW RIGS

Various types of saw rigs with gasoline engines mounted together are described in Bulletin No. [illegible] of the C. H. & E. Manufacturing Company, 254 Mineral St., Milwaukee, Wis.

RUST PROOF PAINT

The Armor Oil & Chemical Company, 3122 Roanoke Rd., Kansas City, Mo., issues a pamphlet describing rust prevention and rust proof paint.

SEWAGE PUMPS AND EJECTORS

Bulletins of the Yeomans Bros. Company, 1433 Dayton St., Chicago, give very complete details, diagrams and tabulated data on sewage pumping equipment. Other bulletins treat of other types of pumps.

SEWAGE SCREENING AND CLARIFICATION

Bulletin No. [illegible] of the Dorr Company, 101 Park Ave., New York, describe their special screens, [illegible] and clarifier and their operation.

GARBAGE AND NIGHT SOIL DISPOSAL

Covered and [illegible] steel vehicles, pumps and other items of equipment for the disposal of garbage, the cleaning of cesspools, etc., are described in the catalog of George H. Holzbog & Bro., Jeffersonville, Ind.

REFUSE INCINERATORS

Descriptions of several different methods of garbage and other refuse disposal together with [illegible] accounts of numerous incineration plants, are given in the catalog of the Decarie Incinerator Company, Minneapolis.

SEWER CLEANING EQUIPMENT

The Kuhlman patent sewer cleaner and its use are described and prices quoted in the catalog of the Champion Corporation, 224 Chicago Ave., Hammond, Ind.

Railways and Excavation Monthly Issue

ENGINEERING AND CONTRACTING

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Roads and Streets—1st Wednesday
(a) Roads
(b) Quarries and Pits
(c) Streets
(d) Street Cleaning

Waterworks and Hydraulics—2nd Wednesday
(a) Water Works
(b) Irrigation and Drainage
(c) Sewers and Sanitation
(d) Waterways
(e) Quarries and Pits for Ballast and Concrete

Railways—3rd Wednesday
(a) Steam Railway Construction and Maintenance
(b) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures

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A Suggested Appraisal of Railways That Will Be Fair to All Concerned

By HALBERT P. GILLETTE, Editor.

A very serious economic problem confronts the steam railways if they are to be consolidated into a few groups. The main question, perhaps, is one of valuation. Upon what basis of value shall different railways be united? Shall it be upon the estimated cost of reproduction (historical or present) of the respective lines? If so, an unprofitable railway would be rewarded and a profitable railway penalized.

On the other hand, if the respective values are based on capitalized prospective net earnings, the Interstate Commerce Commission will apparently be confronted by an illogical method of valuation for rate-making purposes, since the commission aims to base the net earnings on the value of the property. How is this "vicious circle" to be avoided, and at the same time how is economic merit to be rewarded?

With full appreciation of the difficulties involved, I offer the following tentative solution of this economic problem.

Let it be assumed that the steam railways, regarded as a single system, are entitled to net earnings (after taxes and depreciation annuities) equivalent to, say, 7 per cent on their cost of reproduction new. Then let each existing railway system receive its pro rata of this total reproduction cost in the proportion that its prospective net earnings bears to the total prospective net earnings of all the railways combined.

By this plan there would be no circular reasoning as to the rate-making "value," for that would be based on cost of reproduction of the entire railway property in America.

By this plan there would be no penalizing of relatively profitable railways, and rewarding of relatively unprofitable railways. Competitive conditions have produced a rate structure that automatically tends to give relatively large profits to well located and well managed railways. This is economically sound. Taking America as a whole, relatively few of its railway lines should not have been built, and since perfect foresight is not to be demanded, it follows that the public should pay a fair return on some rate-making value of the railways taken collectively. I suggest cost of reproduction new as a fair rate-making base, because it puts investors in railway securities on a parity with owners of other kinds of income producing property—farms, factories, business buildings, mines, etc.

Practically all classes of property, except railways and other public utilities, have risen in value sufficiently to offset the depreciated buying power of the dollar. This is economically sound, and not only justice but true public economy plead for the same treatment for owners of railways and other public utilities.

Seattle's Fiasco in Municipal Ownership of Traction Lines

Seattle has followed closely the path of failure that was blazed by San Francisco in its municipal ownership of street railways.

On the first of April, 1919, Seattle began operating all the traction lines that serve its people, having paid $15,011,000 for a plant that had cost more than $15,000,000 to construct. The editor can speak with assurance on this matter of cost, having not only appraised the plant in 1911, but having also analyzed the ledgers of the then existing company and its predecessors. There has been some question raised by the advocates of municipal ownership as to whether or not Seattle paid an excessive price for the street railway system. It has been asserted, for example, that $10,000,000 was nearer the cost of the plant than $15,000,000. But both ledger records and the editor's appraisal of the physical property gave substantially the same total. The editor's appraisal of the physical plant cost was $15,311,060 as of Dec. 31, 1910. What was added to the plant during the subsequent nine years, up to the time of its purchase, the writer does not know.

In 1910 there were 193 miles of equivalent single track, so that the cost of the plant and equipment was $79,300 per [illegible] per mile that [illegible] San Francisco [illegible] and equipping [illegible] Seattle and [illegible] San Francisco [illegible]. The street railway [illegible] per cent [illegible] private companies [illegible] Seattle [illegible] than the actual cost of the [illegible] plant.

[illegible] Seattle [illegible] traction [illegible] for [illegible] now for [illegible] fully [illegible] failed so [illegible] failure, [illegible] high a price [illegible] for a plant built by private companies, what is to be said of San Francisco [illegible] for a plant [illegible] per cent more [illegible] by the city itself.

Seattle [illegible] tickets for a quarter [illegible] revenue, so in 1920 the fare was raised to 10 cts. for single fare, and three tickets for a quarter. These are as high fares as are charged in any [illegible] city in America.

Seattle [illegible] from the streets [illegible] the private company owned the traction lines, but [illegible] the lines passed into the city's possession.

Seattle refused to lift from the company the excessive [illegible] of maintaining the paving between car tracks and [illegible] thereof, but this great burden is now removed from the street railway department and placed on the general public in the form of taxes.

Seattle burdened the company with a huge load of taxation, but this burden is no longer placed on the traction lines, because the city owns them, but is shifted onto the general public. Yet in spite of all this, and in spite of high fares, Seattle's municipal lines are a white elephant, as the following figures for the year 1921 show:

[illegible]	$6,[illegible]
[illegible]	[illegible]487
[illegible]	$1,231,[illegible]
[illegible]	[illegible]
[illegible]	$[illegible]4,842

A depreciation annuity is included in the $5,105,487, and it amounts to [illegible] or about [illegible] per cent of the cost of the depreciable plant. It has been claimed that this is an excessive allowance for depreciation, and that $100,000 would be ample. Few experienced engineers would agree with such an estimate of [illegible] per cent of the cost of an electric railway plant as being an ample depreciation annuity. Most engineers would put [illegible] per cent as being none too high, and in fact that is the estimate made by the accountants of the Washington Public Service Commission for this particular plant.

From the apparent net gain of $[illegible]4,842, certain deductions are made for "delayed losses in prior period," leaving a final net balance of $[illegible] for the year 1921, or less than 1.5 per cent of the total cost of the plant. But since the lost taxes would be fully three times this 1.5 per cent, there results a net loss of about $[illegible] for the year, exclusive of many expenses paid out of the city "general fund" and not charged to the street railway department. We should not be surprised were an investigation to disclose that such expenses totaled $[illegible] for 1921. The report for 1919 indicated that such "general fund" expenses were running at the rate of about $[illegible] a year, and this did not include paving maintenance [illegible] borrowed from the general fund.

Taking into consideration all such items and the taxes that the city is losing through municipal ownership of its traction lines, there was a loss of fully half a million dollars for the year 1921.

Seattle badly needs an annual investigation of its municipally owned public utilities by competent consulting engineers who would have no object in concealing the exact results of municipal ownership. There is slight hope of such annual investigations, however, first because local politicians are not usually anxious to have the facts fully known by the public, second because the public prefers to think that it has made no mistake in going into the business of running its traction lines.

Prices of Electric Machinery in 1914 and 1919

Manufacturing census data for 1919 are now available for comparison with 1914. In some few instances it is possible to derive the average unit prices during those two census years. For example in 1914 there were manufactured 133,492 direct-current motors having a total horsepower of 980,820 and a total value (at the factory) of $13,316,489. This is equivalent to about $13.[illegible] per horsepower for motors averaging about 7.4 h.p. In 1919 the output was 1,151,286 motors, totaling 2,559,526 h.p., having a value of $52,430,381. This is equivalent to about $20.5 per horsepower for motors averaging 2.22 h.p. Unfortunately there is such a wide difference in the average size of these motors in 1914 and 1919 that no very accurate inference can be made as to the change in price.

In 1914 the output of steam-turbine, alternating-current generators was 275, totaling 440,185 kw., valued at $3,895,291. This is equivalent to about $[illegible] per kw. for turbo-generators averaging 1,600 kw. each. In 1919 the output was 675 turbo-generators, totaling 1,962,7[illegible] kw., valued at $8,262,802. This is equivalent to about $4[illegible] per kw. for turbo-generators averaging about 2,[illegible] kw. each. Here is a reduction of 33 per cent in price per kw. at a time when the general price level was double the level of 1914. In part, this remarkable reduction is ascribable to the increase in the average size of the units, for 144 of these turbo-generators totaled 1,236,827 kw., or an average of about 8,700 kw. each. In part, however, the reduced price is ascribable to better design and to the enormous increase in output.

In 1914 transformer output totaled 115,843, having a total capacity of 2,644,794 kw., and a value of $13,120,065. This is equivalent to about $50 per kw. for transformers averaging about 23 kw. In 1919 transformer output totaled 382,929 and 14,484,179 kw., having a value of $25,560,901. This is equivalent to about $17.60 per kw. for transformers averaging about 37 kw. This is likewise a remarkable reduction in price, doubtless attributable largely to a great increase in the percentage of large sized units.

A Fallacious Economic "Law" and It's Use by a Great Banker

The "law of diminishing returns" is not so frequently referred to as once was the case. But it is occasionally cited by prominent men who seem to regard it as being securely established. For example, James S. Alexander, president of the National Bank of Commerce in New York, last week said:

"We have established upon this continent an economic society that has given to the average laboring man a higher standard of living than his fellow laborer enjoys in almost any other part of the world. The existence of that standard constitutes one of the greatest achievements of American democracy.

"This standard, however, has been conditioned upon the maintenance of the productivity of the laborer and this productivity in turn has been conditioned upon the continued enlargement of the supply of highly productive land as fast as population grew.

"While there still undoubtedly exists a considerable amount of land which may be cultivated more profitably than land which is cultivated in some other parts of the world, yet we must recognize the fact that we have reached the point where upon the new land the operation of the law of diminishing returns in agriculture will cause a smaller and smaller yield of foodstuffs per unit of labor than has resulted in the immediate past. It is true that invention and improved methods of farming have tended to postpone to some extent the early working of the law of diminishing returns but the evidence of the last few years points clearly to the fact that we are now utilizing less fertile land at a greater per unit cost of production than was the case in former years."

There are two serious errors in this argument: First, the error of supposing that the high standard of American productivity "has been conditioned upon the continued enlargement of highly productive land as fast as population grew", and, second, the error of supposing that there is any such "law of diminishing returns" as the "law" evidently in Mr Alexander's mind.

Without going back of economic writings 70 years old, we may quote from John Stuart Mill's "Principles of Political Economy":

"It is the law of production from the land that, in any given state of agricultural skill and knowledge, by increasing the labor, the produce is not increased in equal degree."

Then he formulates the law of diminishing returns thus:

"Every increase of produce is obtained by a more than proportional increase in the application of labor to the land."

Mill, it will be seen, was careful to qualify the first statement of the alleged law by the clause "in any given state of agricultural skill and knowledge," but he forgot this important qualification when he formulated the law, and thus enunciated a generalization that is false.

This false law still mars the pages of many a modern text book (Taussig's, for example), producing the impression that at least in agriculture, if not in manufacturing, there is an inevitable trend toward diminishing returns from equal human effort. To political economists who believe in such a law, we commend a reading of "Burbank's Book," a twelve-volume treatise, only a very small part of which needs be read to satisfy anyone that there is no such thing as a law of diminishing returns in agriculture, if reference is had to the diminishing return laws hitherto published. Burbank is an inventor of new plants, and his work alone serves to show that there is in sight no limit to agricultural economic progress. He has himself so enormously increased the crop yield per acre for many crops without increasing the labor involved, that we can not doubt his statement that only a beginning has been made along this line.

The head of one of the great banks of America tells us that the "early working of the law of diminishing returns" has only been postponed by invention. Well, if invention has "postponed" the effect of this alleged law, what is to prevent invention particularly of the Burbank type from "postponing" its effect indefinitely? The truth is that the diminishing return law never was a law, and never will be. It is one of those products of the ill informed brains of political economists of the so-called classical school, whose utterances still pass current among many non-scientific men.

Mill, for example, was so unscientific that he repeatedly used the term "law" when he meant "force," and otherwise showed a very limited understanding of natural science. He tried to improve on Herschel's rules for scientific discovery, and even sought to appropriate them as his own, calling them "canons of induction." He failed to improve Herschel's rules, and in fact converted them from lucid, accurate statements into involved and often erroneous statements. And he failed to fool many scientific men into believing that there is any difference between a "rule for scientific discovery" and a "canon of inductive proof."

We urge every engineer to study political economy, but always critically, for probably 90 per cent of its alleged "laws" are either too general or entirely false.

A Plea that the Habits of Writing and Magazine Reading be Established in College.

To the Editor:

One evening not long ago several members of the engineering profession were discussing their university training and several things were brought out that impressed them as being particularly worthy of attention.

They were mainly these: That while many relatively unimportant and uninteresting subjects which had been forced upon them while in school, they had already forgotten; one subject which should have been taught had been entirely neglected or ignored. This subject, which would have been of the greatest value to them in their later practice, should have been a course of study in the many modern magazines devoted to their profession, coupled with a chance to learn to write and speak clearly in untechnical language on technical subjects, so that the man without engineering training could easily understand and appreciate any engineering problem or project that they might wish to present to him.

In all of their cases there seemed to be the same feeling that their schooling had lacked the essential element of preparing them to speak easily, clearly and fluently to a lay audience on technical subjects which might be of the greatest importance to both the engineer and the audience. In many cases the failure or success of a project has depended upon the engineer's ability to make his audience understand clearly the project and so gain their good opinion and backing.

Such a course might easily be given. It need not be laid out in advance to the set study of any particular problems, but should be open to the most interesting topics of the day as discussed in the current magazines. There is no doubt that one of the most important things that is learned at school is location and use of references connected with our work. The present high standard, professional magazine is the most important of our references, and its use should be taught in the school and not be left to the student to accidentally discover.

There is a tendency in all schools for both the student body and the faculty to look upon the faculty as knowing the last word on any subject, and a feeling that the student must accept their view without question, thus stifling the individuality of the student. Such a course as I suggest would have a tendency to correct this, as the discussions brought out on the various topics brought up in the magazines would show honest differences of opinion by their writers. Such a course could be made to carry interest into many other classes; for example, instead of a course cut and dried on stresses and strains in bridge design, a particular success or failure in bridge design then under discussion in the magazines could have been used to add infinitely more interest to the class. How interesting it would be to review the articles written on it, and to discuss them; and how much might the student get from it! It would be almost practical experience.

Again there are many small items of no great consequence perhaps, but which are interesting and deal with some special problem that some engineer has encountered and solved or failed to solve, which might be taken up. The method which was used might be improved upon by some member of the class, or a failure turned into a success by the application of some other method. Would not this carry an influence into the student's latter life, and make him more eager and capable of relating to the rest of his profession some unusual problem of interest that he might meet in latter practice?

If he were backed by such a training, could the engineer not easily write up experiences briefly and concisely in such a manner that magazines would be glad to publish them, and the rest of the profession receive the benefit? How many of us meet and solve problems in the field that are perhaps similar to those perplexing others, who would be glad to get our information, but who fail to do so because we either fear our ability to write of our experiences, or because of lack of training begrudge the time that we must necessarily put on the work?

How much more successful in a practical and educational way would our technical magazines become if all engineers were enabled to write short articles occasionally! How much easier and interesting it would make it for them to follow someone else in discussion!

That one of the studies of greatest value to the future engineer, the modern professional magazine, should be almost totally neglected by our educational institutions seems to be a shame. LYNN MARTIN, E. M.

Glenwood, Minn, April 11, 1922.

Grade-marking of lumber will be one of the important features of conferences to be held with Secretary Hoover in Washington, beginning May 22. It is said that lumber is the only building material carried in stock by the average retail lumber dealer which does not bear either the name of the producer or a specific guarantee of quality.

Detroit M. O. Retains Old Superintendents.—Joseph S. Goodwin, General Manager of the railways newly acquired by the city of Detroit, has announced that all division superintendents of the Detroit United Railways will be taken over by the city.

Raising Track — Reasons, Requirements and Methods*

The raising of track, one of the fundamental operations in maintenance work, would seem to have been so thoroughly threshed out that further discussion of it [illegible] only justified by the very many examples the country over that prove it is not being properly done. Small details are often neglected, and the entire system of planning the work [illegible] crude, often [illegible] that it may not be amiss to recall a few elemental truths. We may consider the subject in three of its phases, namely: (1) Why should or should not a piece of track be raised? (2) When should the work be done? and (3) How should it be executed in detail?

The principal reason for raising track is poor ballast. This includes ballast that has been pulverized, hardened or cemented, become deadened by the pounding of traffic or that has become choked with engine cinders and dirt. Such ballast as broken stone, suffering from the last mentioned to such a degree that surface water does not drain through it and is apt to cause soft pumping track, may be rendered almost as good as new by cleaning with forks or with any of the numerous cleaning devices developed during recent years. Machines are preferable, because they shake up the entire roadbed and restore its elasticity. Some track, due to narrow shoulders, and ballast hardening along its center, becomes "center-bound," and requires raising for a good surface. Considerable track is lifted on account of pumping action and also on account of surface-bent rails, the object being to secure a new and firm foundation.

Very often the conditions cited are absent, and yet track is raised in order to cover up some poor work in the past. In other cases this operation could be postponed for a year, at least, without detriment to safety or comfort. Therefore if the trouble is mostly at the joints, an effort should be made to dig out the caked mud or dead ballast at these points, going well below the bottom of the ties, then filling in with new material and finally leveling up the joint with subsequent thorough tamping and tightening of the splices. Not only is this a quicker operation, but it obviates the use of much material and labor and leaves the track on the old, solid bottom.

Disturbing ballast the full length of the tie often involves removing ties that would last at least one more year in the original position. In the case of center-bound track it may also be possible to dig out the hard stuff at the center and then make a light lift. Even if found desirable to raise, the hard material should be broken up with picks preparatory to spreading the new ballast. Bent rails will not be straightened out by merely placing on a new bottom, unless steps are taken to actually bend up the low spots. Where the trouble is only slight it may be corrected or at least checked by working on the joints as before mentioned, getting them, if anything, a shade too high, so that traffic will pound them level. An uneven surface, especially on curves, means rough and dangerous track. It means loose bolts and broken splices and rails. It is a vital defect, but whether it should be corrected by a general raise, as compared with spot raising and leveling of joints, should be decided after consideration of the facts presented.

It would be as inappropriate as it is unnecessary to raise all track every year, even if ballast was to be had at no cost and in any quantity desired, for the reason that section gangs are [illegible] in number and size. The foreman who tries to lift his entire section in one season will have the roughest track of all in the majority of instances, whereas the one who only raises [illegible] once every two or four years will probably [illegible] that are offered, because he has the time to do the work thoroughly. He does not have to [illegible] his effort and requires a minimum of material. Furthermore, where physical obstacles place a limit upon the ultimate height that track can be raised, it is most essential to get the utmost service out of each track raised, because it postpones the time when the expensive and tedious method of digging out ballast must be practiced. In the latter event it is necessary to go at least three inches below the existing bottom of the ties, in order to secure enough good ballast underneath to allow solid tamping.

The second consideration is not the source of very much trouble or contention. Track should not be raised in the spring until all the dangerous or rough conditions that have developed during the winter have been eliminated. In no case should it be attempted until every bit of frost has left the roadbed, after the freezing of the ground has already begun. Track raised with frozen ballast below it cannot be uniformly tamped, and the result is that unsupported places are left which are very apt to cause broken rails and wrecks. After the roadbed is frozen it should not be disturbed, but if it should become necessary to resurface the rails it should be done by shimming.

The final consideration is of very much importance, for neglect in the details of the work results in much waste of effort. It must be clearly emphasized that there is no sharp line of distinction between the details of different kinds of track work. In other words, surfacing is not complete without lining; and, vice versa, neither can be properly executed unless attention is also paid to such matters as tie spacing, tightening of the bolts and back filling with ballast. Very often proper judgment has been used in raising a stretch to the proper height, and although it has also been lined, backfilled and thoroughly tamped, it very soon loses its good riding qualities. The commonest alibi of the foreman in such a case is that "the rail is bent too much to be able to do anything with it." Upon closer analysis it will probably be found that the original bent splices were retained, which naturally soon brought the rail ends back to their old crooked contour.

Sometimes failure in following up the job in getting every bolt tight is the cause of the trouble, for loose bolts mean loose joints, which in time mean pumping track and bent ends, slewed ties, tight gage and a ruined surface. Furthermore, it is not to be expected that one lift without subsequent touching up will make new rail out of old. On the other hand, the best practice is to send about two men ahead of the gang with a jack to raise the low spots and level the joints. This not only simplifies the work of the gang, but in reality makes their job a second application of the worst places. Even that does not end the program, however, for after trains have passed over the section for several days irregular spots will appear. These should be promptly corrected, doing all the tamping with picks and being sure to tamp from the end of the ties to about a foot inside of each rail. If such procedure has been followed, this particular stretch will not have to be touched for several years. It will be smooth and safe and the life of the rail, together with all its fastenings, will have been considerably lengthened. About the only attention it may require is the occasional tightening up of a few loose bolts or the touching up of a low spot.

The height to which a raise should be made is somewhat dependent upon physical conditions. Raises of more than six inches should be made only to correct irregularities in profile, to get above a low, wet spot, to provide ditches in cuts or to get a standard depth of ballast. A raise of more than six inches should not be made in one operation. It is far preferable to raise twice, making the second lift the lighter of the two; otherwise it will be almost impossible to get a uniform surface. A raise of less than two inches is of questionable benefit, for it does not allow of solid tamping. This matter of tamping is perhaps the most important, as well as the most neglected, single operation in track work. Foremen are not persistent enough in making the men tamp hardest underneath the rail, and in making them tamp inside the rails. Furthermore, in the effort to cover much territory and make a showing they do not use the pick. Shovel tamping, while fair, is not nearly as permanent as pick tamping or pneumatic tamping.

The sum and substance of all the foregoing is that each piece of track must be studied in detail. The foremen and supervisors are the doctors, and the test of their ability is not only in curing a certain roughness in the track, but in preventing or delaying the appearance of any irregularities. They must be thorough; and, rather than cover much territory, should be trained to do perfectly whatever they undertake. Making speed slowly is the cheapest practice in the long run.

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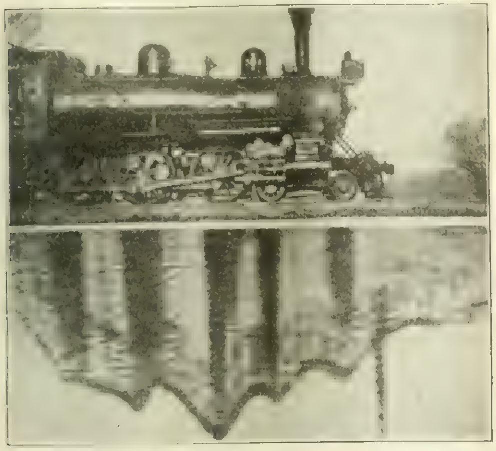
*From the Railway Review.

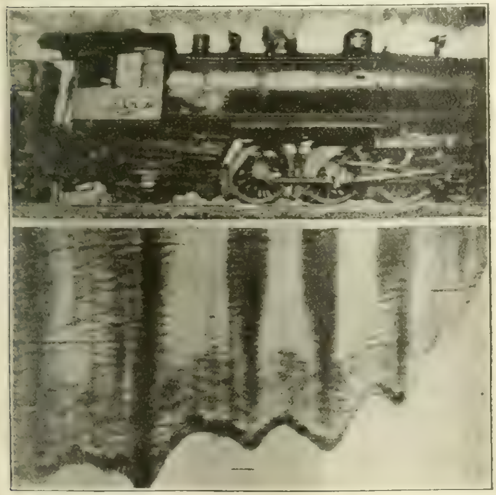
Track Stresses Studied Photographically*

In view of the widespread interest which engineers and metallurgists are taking in the question of the magnitude of the stresses which exist in rails in service, it is interesting to note that the art of photography has been applied to the study of this problem by H. F. Roach, president of the Reinforced Rail Joint Company, St. Louis, Mo. In this investigation, Mr. Roach has photographed locomotives and the deflections which they produce in the rail in a way which has magnified the deflections many times vertically without distortion horizontally to enable them to be studied more intelligently.



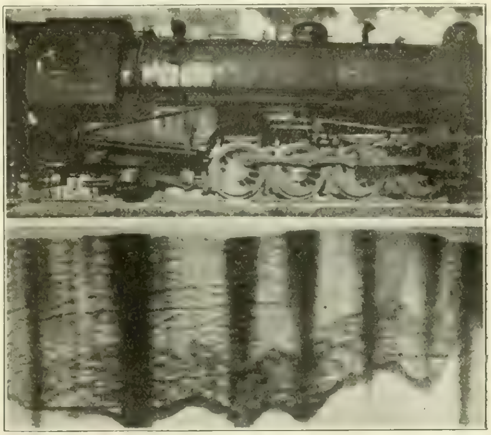
A Light Locomotive at Starting Speed With a Graph of Rail Deflections on a Vertical Scale 400 Times the Scale of the Photograph.

This method of photography has been applied to the study of the action of rails in the eastbound track of the St. Louis-San Francisco near South Webster, Mo., under (1) a light passenger engine starting from a stationary position, producing a maximum stress in the rail of 61,390 lb. per sq. in.; (2) a locomotive pulling a heavy passenger train at a speed of 55 miles per hour, resulting in a maximum stress of 36,810 lb. per sq. in., and (3) a heavy freight locomotive traveling at 25 miles an hour, producing a maximum stress of 33,030 lb. per sq. in. The track on which these observations were made is laid with 90 lb. A. S. C. E. rail supported on good ties imbedded in chats ballast and with good drainage. The track at the point of observation is tangent. The illustrations show the locomotives passing over the track in question and the graphs of the distortion which they produce.



A Heavy Freight Locomotive Traveling at 25 Miles Per Hour With a Graph of Rail Deflections on a Vertical Scale 400 Times the Scale of the Photograph.

In a report to F. G. Jonah, chief engineer of the St. Louis-San Francisco, Mr. Roach claims that the method of investigation makes it possible to determine (1) the rail stresses at any point for any position of load or loads; (2) the points of maximum stress; (3) the stress in rail joints at any point and for any position of load or loads; (4) the effect of the counterbalance of the locomotive drivers both collectively and individually, and also whether the equalizers are properly installed so as to distribute the load over the respective drivers as intended; (5) the tie reactions, and (6) the work being done by the ballast. Attention is also directed to the fact that with a high grade moving picture camera with a fast lens as many as 800 pictures per second may be taken which will make it possible to take a picture of the track for every 1⅓ in. of progressive movement of a train moving at a speed of 60 miles an hour, by which means the complete distortion of the rail can be shown.



A Heavy Passenger Locomotive Moving at the Rate of 55 Miles Per Hour With a Graph of Rail Deflections on a Vertical Scale 400 Times the Scale of the Photograph.

Mr. Roach has applied for a patent on this development.

Reclaiming Old Rails by Clipping Damaged Ends.—The Nashville, Chattanooga & St. Louis Ry. expects to start operating its new rail clipping plant at Nashville about May 15. The cost of the plant is said to be $30,000.

About one foot of each worn end will be clipped off, the webs rebored, and the rails returned to service practically as good as new, except for the slight shortening. It is expected that several thousand tons will be thus reclaimed this year.

Great Improvement in Safety of Railway Operation.—The Interstate Commerce Commission announces that there were fewer fatalities on American railways in 1921 than in any other of the 34 years for which full accident figures have been tabulated. Employes killed numbered 1,096, or 48 per cent less than in 1920. Passengers killed numbered 205, a reduction of 24 per cent from 1920, and the smallest number of any year except 1895, 1896 and 1915. The total number of non-trespassers killed showed a reduction of 28 per cent from the preceding year, but fatalities to trespassers increased 14½ per cent.

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*From The Railway Age.

When Preservative Treatment of Wood Is an Economy

Technical Note of U. S. Forest Products Laboratory

Although any set of timbers may be made more resistant to decay by preservative treatment, such treatment may not always be economical even though the timbers are to be exposed to the most severe decay conditions. If the timbers are to be in service for a short time only, durability is unimportant and any kind of preservative treatment would obviously be a waste of money. If, on the other hand, the wood is naturally of low durability and is to be used in a permanent location, it is easy for preservative treatment to show great savings. Between these two extremes there are any number of instances in which it is a more difficult problem to determine whether or not preservative treatment will pay.

If a timber user knows the average life that treated and untreated timbers are giving and the cost of each in place, he can readily compute, with the use of the following table, the relative annual costs of maintaining the two. A mine operator may have found, for example, that untreated timbers are giving an average life of 2 years and that their cost in place is $6 per set. Assuming an interest rate of 7 per cent, the table shows that timbers which need replacement every 2 years cost annually $0.553 on every dollar of their cost in place. For the $6 set, then, the annual maintenance cost would be 6 times $0.553, or $3.32. Treated timbers, the user may find, give an average life of 14 years and cost $7.50 per set in place. The annual charge on timbers with a 14-year life is found in the table to be $0.116 on each dollar of their cost in place. The annual cost of maintaining the $7.50 treated set, therefore, would be 7.5 times $0.116, or $0.87. Preservative treatment, then, would save this user annually $2.45 per set.

If a timber user knows the cost of treated and untreated timber and the average life of the untreated timber only, he can estimate how long treated timber would have to last to be as cheap as untreated timber. In the case discussed above, the untreated timber cost $6 in place; the treated, $7.50, and the untreated timber was lasting 2 years. The annual charge on the untreated set was found to be $3.32, and since the annual charge on the $7.50 treated set is to equal this, we may set up the equation, 7.5 × y = $3.32; then y (the annual charge on one dollar expenditure) = $3.32 ÷ 7.5, or $0.443. Referring again to the table and looking along the 7 per cent interest rate row, we find that an annual charge of $0.443 on the dollar falls between the 2-year and 3-year columns and evidently at a point equivalent to about a 2¾-year life. It can readily be seen from this that if treatment adds only ¾ of a year to the life of the timbers, it would pay for itself, and the user could be sure from the experience of others that it would add much more than this and would therefore be profitable.

If untreated timber is giving long life, treatment might not result in great savings. However, very often it might be possible to substitute for such timber a treated lower-grade material that would give as long or longer life with an annual maintenance charge which would compare very favorably with that of the better-grade untreated timber.

There are several advantages arising out of the use of treated timber which should not be overlooked, although they may not seem so important as cutting down maintenance costs. As decaying timbers are highly inflammable, preservative treatment, by keeping the wood sound, reduces the fire hazard. Then, a well-preserved timber maintains high strength over a long period of time, while a decaying timber rapidly loses its strength. Preservation, by lengthening the life of timber and by permitting the use of low-grade material, also helps conserve a timber user's resources and the nation's timber supply.

Contracting Railway Maintenance

The United States Railroad Labor Board on May 10 ruled that any railroad "farming out" its shop and maintenance work for the alleged purpose of removing its employes from the protection or benefits of the transportation act, or the jurisdiction of the labor board is in direct violation of the provisions of the act. The matter undoubtedly will be taken to the courts for settlement.

Some of the Cases Involved.—The Bulletin of the National City Bank of New York notes the following maintenance contracts recently made.

The Erie R. R. has awarded a contract for maintenance of way and repair work on the Ohio region, covering 400 miles of main track, to the Dickson Construction & Repair Co. This completes the contracting for all the maintenance work of the Erie covering the entire system. The officials say they expect more efficient work along with a saving in cost by this method.

Scranton, Pa., March 7.—The Delaware, Lackawanna & Western R. R. Co. will hereafter have all the freight at its big transfer station in this city handled by contract. Downey Bros., of Binghamton and Rochester, were today awarded the contract.

About 100 men are employed at the station. This will be the third Lackawanna freight station operated by private contractors.

Baltimore, March 8.—The Western Maryland Ry. yesterday announced to its 3,000 maintenance of way employes that at midnight the Dickson Construction & Repair Co. of Youngstown, O., would assume control of maintenance of way work on the entire system. The Youngstown firm, which will undertake the work on a contract basis, plans to retain the railway company's present force of laborers, it is said, with wages reduced from 39½ cents to 25 cents per hour.

The move, which follows the placing of the repair shops at Baltimore and Cumberland on a contract basis, was described by road officials as an economic measure.

Annual Charges on Each Dollar of Cost of Timbers in Place

Interest Rate	Life in years before replacement																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	16	18	20	22	24	26	28	30
4%	1.04	0.530	0.362	0.276	0.225	0.191	0.166	0.148	0.132	0.123	0.114	0.106	0.100	0.094	0.086	0.079	0.073	0.069	0.065	0.062	0.060	0.058
5%	1.05	0.538	0.367	0.282	0.231	0.197	0.173	0.155	0.140	0.129	0.120	0.112	0.106	0.101	0.092	0.085	0.080	0.076	0.072	0.069	0.067	0.065
6%	1.06	0.545	0.374	0.288	0.237	0.203	0.179	0.161	0.148	0.136	0.126	0.119	0.112	0.107	0.098	0.092	0.087	0.083	0.079	0.076	0.074	0.070
7%	1.07	0.553	0.381	0.295	0.243	0.209	0.185	0.167	0.153	0.142	0.133	0.128	0.121	0.116	0.109	0.103	0.097	0.092	0.088	0.086	0.083	0.081
8%	1.08	0.561	0.388	0.302	0.250	0.216	0.192	0.174	0.160	0.149	0.140	0.133	0.127	0.121	0.113	0.107	0.102	0.098	0.095	0.093	0.090	0.089
9%	1.09	0.568	0.395	0.309	0.257	0.223	0.199	0.181	0.167	0.156	0.147	0.140	0.134	0.128	0.120	0.114	0.110	0.106	0.103	0.101	0.099	0.097
10%	1.10	0.576	0.402	0.315	0.263	0.227	0.205	0.187	0.173	0.162	0.153	0.146	0.140	0.135	0.128	0.121	0.117	0.114	0.110	0.109	0.106	0.105

Based on the formula, $A = P\frac{(1+r)^n r}{(1+r)^n - 1}$, in which
A = annual charge.
P = amount of initial investment.
n = number of years in the recurring period (the average life of the timber).
r = the rate of interest expressed decimally.

Possibilities in Liquid Air Explosives

Equipment, Methods and Comparative Costs Outlined by French Engineer in Article in the Compressed Air Magazine

By EUGENE ROY,
Chief Engineer, Societe de Pont a Mousson.

The use in Germany of liquid air explosives (already known and tried in other countries) was developed to a marked degree owing to the scarcity of nitrates caused by the blockade during the war which did not allow the usual shipments of Chilean nitrates to be made. The use of the Haber process for the manufacture of synthetic nitric acid was reserved exclusively for the preparation of explosives, and this factor certainly permitted Germany to lengthen her resistance. It therefore becomes interesting to consider the results which have been obtained with this type of explosive and what may be expected of them.

The first experiments were made in 1897 when the apparatus conceived by Linde for the liquefaction of air was already sufficiently improved to permit of obtaining liquid air in industrial quantities. More positive trials and on a larger scale followed from 1898 to 1905 during the drilling of the Simplon gallery. A little later, liquid air explosives were tried in the mines. In France they were successfully tried in the iron mines of the Briey district between 1909 and 1914 and particularly in the mines of Aubone and Droitaumont (Meurthe and Moselle).

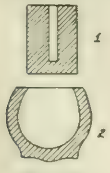
During the war after making the necessary experiments, the use of liquid air explosives became general in the iron mines of Lorraine and numerous applications were made in coal mines, particularly in Upper Silesia.

We will particularly consider the process of preparing and using this explosive, its advantages and inconveniences and finally, since the problem is for the purpose of obtaining liquid air economically, or to be more exact, liquid oxygen because it is this element of atmospheric air which is utilized, we will study the different systems which serve to produce liquid oxygen.

The explosive "substance" carries in itself all the elements of combustion of which oxygen is the most important component. More often the reaction of decomposition does not always result in a predetermined state of the elements entering into the reaction. The quantity of oxygen present affects to a great extent the nature of the resultant gases. This observation has a great importance when it concerns explosives to be used underground where the production of deleterious gases is a hindrance for the good performance of the work. When the oxygen is in excess, the combustion is complete.

Liquid air explosive is simply a combination of a combustible matter such as charcoal, lampblack, cellulose, petroleum, sulphur or aluminum, etc., soaked in liquid oxygen. Generally, the cartridges consist of a paper wrapper containing pulverized carbon such as lampblack intimately mixed with inert matter such as diatomaceous earth.

This cartridge is soaked in liquid oxygen right on the spot where it is utilized and just immediately before it is used. Up to the time of soaking, it is naturally evident that the cartridges and liquid oxygen carried apart, one from the other, do not offer the slightest danger. The cartridge if soaked and lighted in the open, simply burns very rapidly, and it only becomes explosive after having been tamped.



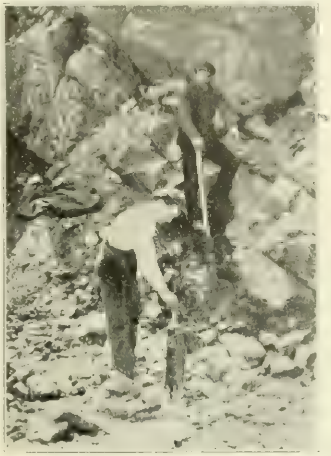
1 Lead Block With Hole Drilled in Center.

2 Effect of 6 Ounces of Dynamite.

3. Effect of 2½ Ounces of Liquid Air Explosive.

Lead Block Tests.

By varying the composition of the cartridge, one may at will vary the breaking capacity of the explosive. It is a curious feature which distinguishes it plainly from an explosive of definite composition. One may obtain slow effects by taking a combustible of coarse grain or by having the carbon diluted with inert matter, either diatomaceous earth or pulverized rock salt. The results then obtained can be compared to those of the so-called progressive powders such as black powders or the German sprensaltpeter. On the contrary, one may obtain greater breaking effects by taking a combustible richer in carbon, more finely pulverized or further, by adding a metallic powder, the oxidation of which is characterized by a strong heat of formation such as aluminum for instance. We may then obtain breaking effects superior to those of all explosives known at present as dynamite or melinite. By varying the proportion of these materials in constant trials there has been worked out what is known as the "Weber" formula named after its inventor, an engineer of the firm of de Wendel of Hayange (Lorraine), for the manufacture of an explosive, the breaking effect of which is two and one-half times greater than that of dynamite.



Preparation of Cartridge Before Introduction Into Drill Hole—Soaking Into the Double Wall Vase Containing Liquid Oxygen.

The trials on the block of lead are instructive as shown in the illustration. Figure 1 shows the lead in trial block with a a cylinder eight inches in diameter, ten inches high, drilled with a hole one and one-half inches in diameter and eight inches deep.

Figure 2 shows the effect of a load of six ounces of dynamite. Figure 3 shows the effect of a load of two and one-half ounces of liquid air explosive (Weber formula) where one sees that the bottom of the testing block has been carried away.

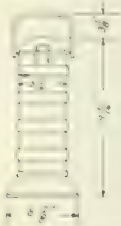
A comparison between Figures 2 and 3 needs no further comment. The greatest degree of detonation, hence the greatest breaking effect, appears plainly in the case of the trial with liquid air. This formula seems to be particularly well adapted for the breaking of the steel blocks.

We have seen above that the soaking of the cartridge into liquid air must be done at the time of using it. Liquid air in reality is obtained at a temperature exceedingly low (-190 degrees C.), about 310 degrees F. and therefore at normal temperature it evaporates rapidly. It is essential to operate rapidly and as quickly as possible. It is also necessary to shoot within several minutes after the soaking. After about ten minutes the cartridge loses its efficiency and may give no results. After half an hour it possesses no explosive qualities.

The necessity of performing rapidly the tamping and the blasting therefore does not allow of firing simultaneously a great number of holes. However, it is possible to blast three of four holes at the same time and the better results of the explosive may easily compensate for this inconvenience.

The tendency of liquid air to evaporate causes a difficulty in transportation to the headings and this is one of the reasons which has retarded its use as an explosive. The problem is solved today by the use of special vases with double walls between which exists a vacuum. The loss by evaporation is about 0.5 per cent per hour for the small vases of three to four gallons capacity and falls to 0.3 per cent per hour for the vases of ten gallons capacity. Therefore these losses are not excessive and do not greatly increase the cost price.

The losses are greater at the time of pouring off the liquid into the soaking vase. It is not possible here to have the "slender collar" which reduces the evaporating surface. The soaking vase which is placed at the disposition of each miner is also a double-walled vessel made of sheet brass or silvered glass which may contain several cartridges. The miner pours out into the vase a certain quantity of liquid oxygen wherein he dips the cartridge to absorb the liquid for about ten minutes' time.


Vase for Preparing Cartridges.

Section Through 5-Liter Vase.

Some of the accompanying illustrations show the vases for transportation and soaking.

The following data will give an idea of the useful effect and the losses incurred in using liquid oxygen as an explosive: A three and one-half ounce cartridge absorbs two and one-half to three times as much of liquid oxygen. In counting the losses one may prepare three cartridges with one liter. To produce 100 liters of liquid oxygen, it is necessary to use seven pounds of caustic potash and five pounds of chloride of calcium for drying the air and 300 kilowatt-hours for the work of liquefaction. The effect produced by a liter of oxygen is more or less equal to that given by:

a—2.2 lb. of black powder.
b—14 oz. of dynamite.

With these figures and knowing each particular case, the price of explosive black powder and dynamite, the surrounding conditions and the price of electric current, it will be possible to figure the economy which may result from the use of liquid air as an explosive.

To sum up the advantages of liquid air explosives are the following:

1. Possibility of adapting the explosive to the kind of rock which is to be blasted in varying the breaking effect.
2. Facility of manufacture of the cartridges.
3. Greater degree of safety in manipulation.
4. Absence of smoke and deleterious gases; combustion is complete owing to the excess of oxygen.
5. Unquestionable saving in every case.

We must just the same add that this explosive in its present state is not to be considered as a safety explosive in dusty or gassy mines and that its use in collieries where the combustible is scattered everywhere around will have to be watched carefully. Even with these reserves, its field of application is nevertheless of wide extent.

Detroit's Danger

The Electric Railway Journal of April 22 contains the following pertinent editorial relative to the complete municipalization of the street railways of Detroit:

Mayor Couzens of Detroit will soon be free to put into full effect his idea of how best to run a municipal street railway. At the election there on Monday the voters cast their ballot to sustain him in his effort to municipalize the entire city system. The Detroit United City Lines will be taken over at the price of $19,850,000, to be paid with a down purchase of $2,770,000, the rest of the price to be paid in installments. The present municipal system will now be tied in with the lines which the Detroit United has been operating, and the United States will witness the most important experiment in municipal ownership of a city railway system so far made in this country.

Jim Couzens is a big man. He has a genius for getting things done. The wisdom of his ways may be open to question, but there is no controverting the fact that the work of building the municipal road so far constructed during his administration of affairs in Detroit has been carried out with celerity. While he is in office his best efforts will undoubtedly be devoted to the careful management of the road along sound lines. But Jim Couzens is an anachronism in American public life. When the day arrives that he goes out of office Detroit's troubles will begin in earnest. For if Detroit runs true to American political form the likelihood is very remote of that city electing as his successor a man with either his qualifications for office or his determination. It is here that danger lies ahead for Detroit.

Railway Maintenance by Contract Prior to the Civil War

While it is quite generally known that railway maintenance by contract long antedates the present controversy over that subject, it is of interest to note that such contracts were in effect in "the fifties," and apparently with satisfactory results. What follows is taken from a recent report or bulletin of the Pennsylvania R. R.:

"The first mention of the contract system on the Philadelphia, Wilmington & Baltimore R. R. is in the annual report for 1854. Samuel M. Felton, Sr., president, said a plan had been 'examined and discussed,' and referred to it as being, in his opinion, adapted to secure the greatest economies both in labor and materials. He predicted its general adoption throughout the country.

"In the report for the next year Mr. Felton states that the 'contract system' had been placed in partial operation for the latter six months of the year and had effected a saving of $33,070 in operating expenses. Expenses for the first half, when no contracts were in effect, were $209,083 and for the second half, $176,013. A typical comment from the annual report of 1856 follows:

"'All the trains are now run at a stipulated price per mile, including repairs and renewals of locomotives, fuel, oil and waste and wages of enginemen and firemen. The labor on repairs of road is also furnished by contract. The freight business is paid for by the ton in all its details, including loss and damage and wages of conductors and brakemen. The fuel for all the stations, shops, steamboats, cars and for the ferry is furnished for a stipulated sum per year. This system, more effectually than any other, brings to bear upon the affairs of the company the element of individual responsibility, the true element of success in any business.'

"In the annual report of 1858 Mr. Felton attributes the regularity of train movements and practical freedom from accidents to the operation of the contract system. In the report for 1860 Mr. Felton said the work is better and more cheaply done and with more regularity and safety than under the old system. "We feel confident that in our case it has contributed largely to the success of the road.

"The broad scope of the contracts is indicated by an entry in the directors' minute book, showing that on June 17, 1856, President Felton reported that responsible parties had submitted offers, for one year, to supply under contract all wood, oil and waste; to keep engines in repair and furnish men to run them; to furnish labor to keep the road in repair; to lay new track and turnouts not exceeding seven miles; to furnish all labor in the freight department and clerical hire; and to take all risk and damage to freight in transit and all loss on freight in collection. President Felton recommended acceptance of these offers, which the board approved."

The contract system on the Philadelphia, Wilmington & Baltimore R. R. proper passed out of existence during the Civil War. On the affiliated branch lines in the Delaware Peninsula remnants of it survived about two years after the close of the conflict.

There was a time when the public took an attitude of the railroads be damned, but today they are learning that to damn the railroads is to damn national prosperity.—Chicago Journal of Commerce.

Methods of Treatment of Slides and Soft Spots in Excavations and Embankments

The methods employed and the results secured in the treatment of sliding cuts and fills are soft spots in excavation and embankment were described by a subcommittee of the Committee on Roadway of the American Railway Engineering Association, in a report submitted at a recent 23rd annual convention of the Association. The subcommittee, of which C. A. Daley was chairman, sent a questionnaire to 15 of the larger railroads in different parts of the United States and Canada. The replies were embodied in the report, an abstract of which follows:

Slides will be treated in two classes, namely:

Class "A"—Surface slides of small volume.

Class "B"—Slides or slips of great volume which do not as a rule come as an avalanche but are of slow movement.

Surface slides occur in nearly every class of material and combination or mixture of materials, except rock, in both excavations and embankments and are caused largely by the ground becoming saturated. The extra weight of the water in the ground upsets the equilibrium and reduces the cohesion and a slide is the result. In North climates the action of frost greatly facilitates the action of the water by opening up crevices and making the ground porous.

Treatment of Surface Slides in Excavations.—Surface water should be kept from the face of cuts as much as possible by the use of intercepting ditches constructed well back from the top of cut. These ditches should be constructed with care and should be well maintained so as not to let pockets form to hold water that will eventually soak into the ground and may be the cause of a slide.

Good results have been obtained in deep cuts where excavations have been taken out in such manner as to permit it by the construction of ditches on a table or shelf part way up the slope and the water carried off.

Where cuts have a large number of springs on their surface, small concealed tile drains have been laid down the slopes to the ditches in order to keep the water from the numerous springs and saturating the soil.

In many cases excellent results have been obtained by facing cuts with layer of engine cinders or fine slag about 6 in. deep. This tends to distribute any water reaching the face of the cut and prevents cutting, and also lessens the action of the frost. Where this method is used the cut should be faced to a reasonably true plane before the application of the coating.

In cities and towns sodding of slopes has been carried out with good success, but on account of the cost, this method of treatment has been confined mostly to densely inhabited districts where the esthetic value of this method is given consideration.

The planting of vegetation (not trees) on the slopes of cuts has proven very successful in the cure of slides. A mixture of seed that has been found very desirable for this purpose, in climates where it will grow, is two parts by weight of alsyke, two parts alfalfa and one part blue grass seed. Where the soil is poor it is desirable to enrich it with street sweepings or manure. Small wooden stakes should be driven into the ground at about 12 in. centers to hold the dirt and vegetation until the roots are long enough to get a good hold in the original soil. It is also well to sow oats or rye with the seed as this shades and protects the smaller grass. The real success, however, in obtaining growth of vegetation on cuts to assist in preventing slides is to properly care for the young grass for the first couple of years. Mowing should be done frequently and the grass should not be allowed to go to seed. Japanese honeysuckle and Bermuda grass have also been planted on cuts with good results.

Treatment of Slides of Embankments.—Small slides of embankments are treated in practically the same manner as above mentioned in cuts except for the drainage. The slopes have been sodded and faced with cinders in a manner similar to the treatment of cuts and with equal success. The flattening of the slope and the weighting of the toe of the slope with derrick rip rap where it is practical to do so, and where the toe of the slope is subject to the action of running or standing water, has proven successful. Embankments that have given trouble for a long time when treated in this manner have become stable. In one case it was necessary to place rip rap well out in the bed of the stream to accomplish the desired result. Where the embankment is not subject to the action of water, the use of either two or three man rip rap will answer the purpose equally well. The same result has been accomplished by the construction of a false berm approximately one-third the height of the embankment.

In low-lying country where there is a large amount of surface and ground water, considerable trouble has been experienced in holding fills. To overcome this ditches have been dug near the right-of-way line some distance from the toe of the slope and the ground water level lowered with exceedingly good results. The depth of the ditches to be dug depends on the fall that can be obtained.

In some cases where the slides are of a minor nature a timber crib or loose stone retaining wall built in the toe of the slope on an angle approximately equal to the angle of slope has proven effective.

Large Slides or Slips.—Slides or slips of great volume are hard to remedy. Each case must be studied and the cause determined, if possible, and this cause then removed. In nearly every case it is underground water or seepage that causes the trouble.

When a study has been made of the movement and its cause determined it is generally found that the slipping occurs on a strata of inclined rock or clay. Sometimes the strata of clay is only an inch or so thick. Water reaching the strata of rock or clay is retained and forms a lubricant which upsets the equilibrium of the mass and the slide starts. The remedy is, of course, to intercept the water and to prevent it following the strata.

The following are some interesting experiments which have recently been carried out:

Curing Slide by Intercepting Ground Water.—An instance in which the water was intercepted on a strata of clay about 100 ft. below the surface of the ground and which has proven successful in curing serious slide is reported by the Kanawha & West Virginia Ry.:

Holes were drilled about 75 ft. back of the top of slope of the cut and 75 ft. apart. A total of 11 holes were drilled ranging from 95 ft. to about 130 ft. deep. These holes were from 110 to 190 ft. from the center line of the main track. They were drilled from 8 to 10 ft. into a soapstone formation on top of solid rock 20 to 25 ft. below grade. It was necessary to case the top part of the hole in the sand clay and boulders, the balance of the hole standing in good shape without casing. As soon as the hole was drilled it was sprung and immediately loaded and shot. About 100 lbs. of dynamite was placed in the bottom of rock shot and about 75 lbs. in the upper or blue clay shot which was placed about at the grade of the track or a little below. The holes were filled between the lower and upper shots with sand. The holes had to be loaded and shot quickly after cleaning them, as the water ran in very rapidly. The casing was pulled after the hole was loaded and ready to shoot.

When the holes were shot there was no distortion of the face of the cut or the ground around the hole. The face of the cut was immediately dried up with the exception of a small amount of water that came over from the top in the time of heavy rain. The test is now over two years old and has so far been very satisfactory, and as the slope is now getting well covered with vegetation, no further trouble is anticipated.

The total length of holes drilled was about 1,232 lin. ft. The cost of drilling and shooting was $1,816.92, which represents a cost of approximately $1.47 per lin. ft. of hole. The work was started in May, 1919, and completed in July, 1919.

How a Slide on the S. P. Was Cured.—Another case of intercepting the ground water and thus curing a bad slide of an embankment built on a hillside is reported by the Southern Pacific Co. as follows:

The fill in question was on a side hill in the Santa Lucia Mountain District. It had always given trouble, but during the winter of 1909-10 it became very serious, due to the heavy rains of that winter. The settlement was so great that a very large force of men was constantly engaged, day and bank, in raising up the track after the passing of each train, a steam shovel being required to remove the material. It is estimated that the fill settled during the two months considerably over 100 ft. The sliding material was a quarter of a mile long, the original culvert broken up and carried along with the sliding material, the ground moving along in big folds and waves.

In attempting to find a solution for the trouble, we noted the absolute absence of water around the tracks, except in rainy weather and then only in small quantities. The upper portion of the sliding fill for about 150 ft. in depth was also fairly dry, but below this level water was traced coming out of the toe of the slide, that is, between the sliding material and the solid hillside. Below this point the hill was saturated with water. We reasoned that somewhere about 100 ft. below the track there must be a live spring of water, coming out of the hillside, possibly on the contact between two strata formations. A shaft was sunk above the track and a well defined contact was discovered. The next thing to do was to go down on the face of the solid material, a short distance below where the water came out, and start tunnels on such a grade as to connect with the shaft above. This was done and a large amount of water picked up, one spring cut into flowing at the rate of 300 gal per minute, and during ordinary summer conditions the water, measured at the portal of the main drain tunnel, amounted to over 1,200 gal per minute.

Shortly after the completion of these drain tunnels the track stopped settling, and only ordinary maintenance has been required since then. Several other slides in the immediate vicinity were corrected in a similar manner.

A report from the North Pacific Coast is as follows:

Slips and Their Treatment in Oregon. Throughout the North Pacific Coast territory slides of large volume are of frequent occurrence. The attention of the Committee is called to an article which will appear in a future number of the proceedings of the American Society of Civil Engineers by Mr. S. Murray, Assistant Chief Engineer, O.-W. R. R. & N. Company, concerning a slip of large volume which has been under treatment for a good many years. This slip is in the gorge of the Columbia River, about 45 miles east of Portland. At this point the river cuts through the Cascade Range. On the north side of the river the present slip extends back three or four miles from the edge of the river, but the ground along the river bank has become practically stable so that no difficulty is encountered by the railroad line on that side of the river.

On the south side of the Columbia River the break from the top of the range is only a few thousand feet from the river bank. Great portions of the ground in this vicinity for a stretch of three miles along the river bank are slowly slipping toward the river, carrying with it the railroad which lies close to the river's edge.

Measurements made of this slip during the past 15 years show a movement of 10 or 15 ft., up to 30 or 40 ft., and at some points the original stakes to mark the ground have gone beyond this point into the river and are, of course, obliterated.

This slip has caused considerable difficulty in maintaining the track. The method of treatment as outlined in the paper mentioned in the foregoing has been to run tunnels back into the slipping ground above the track to tap the veins of water and drain the small ponds and reservoirs lying in depressions on the surface.

A slip of a different character has occurred in Eastern Oregon, on a spur of the Blue Mountains. At this point an area of some three or four hundred acres lying along the track for a distance of about a mile has been gradually slipping down the side of the mountain, carrying the track with it. The movement has been very slow ordinarily, although at times it has been of sufficient amount to endanger the track. A study of the character of the ground at this point shows a surface strata of rock and clay to a depth of 2 or 3 ft. Beneath this strata is another of yellow clay ½ to 2 in. in thickness; below the yellow clay, coarse boulders and blue clay.

The yellow clay has acted as a lubricant on the surface strata, permitting it when wet to move bodily. The treatment in this case has been to cut a trench through the natural drainage channels up the side of the mountain, shore it with heavy timbers and extend branches at frequent intervals from it over the slipping area. By this means it is hoped to keep the strata of yellow clay sufficiently free from water to prevent saturation and thus stop the slipping.

In a good many cases where the volume of the slip amounts to several thousand yards, the movement has been stopped by the use of concrete retaining walls, or pile bulkheads. A concrete retaining wall can be used only where a good foundation is procurable and its use is, therefore, considerably limited. In many cases, pile bulkheads have been the correct solution.

In the case of such slips the movement usually occurs only during the rainy season and, of course, the saturation of the ground decreases the angle of repose. Ordinarily the material is very nearly stabilized and only a small force is required to counteract any tendency to slip. For this reason pile bulkheads effectively offer the necessary resistance to hold a seemingly large mass in equilibrium.

Concrete retaining walls and piles have been used in an effort to cure slides of this class but in most cases the best that can be said for the method of treatment is that it affords only temporary relief, for the retaining wall will eventually slide at the base or tip over and the piles crowd out.

Treatment of Soft Spots. Soft spots in excavations and embankments, the origin of which is the result of geological formation, are hard to contend with and no uniform treatment can be applied to all cases.

A method that has been successfully used in both excavations and embankments is the use of long ties.

One of the railroads in the Northwest reports an effective method of treatment by the construction of a reinforced concrete slab of 12 in. thick on which the track is carried. The foundation for the concrete slab is prepared by leveling off the sub-grade and applying a 12-in. layer of good engine cinders. The cinders furnish good drainage and the concrete slab uniformly distributes the load.

In some cases soft spots in cuts have been treated by driving piles along the ballast line with the idea of confining the material, and by driving pile butts from 6 to 12 ft. in length spaced from 3 to 4 ft. directly under each rail and sinking them 2 or 3 ft. below sub-grade. The latter method is reported as being more satisfactory.

Piles have been driven in embankments both along the ballast line and under the rail in a manner similar to the method reported above but the results do not appear to be as satisfactory.

An effective method reported in the treatment of soft spots under embankments is the widening of the embankment until a point is reached where the pressure, due to the load, is distributed over a very large area.

Continue the Use of Labor-Saving Devices in Track Maintenance

For some reason expenditures for track maintenance are usually the first to feel a cut when times are hard and the last to be resumed when times get better. It may be taken as an index that better times are at hand when the news columns of this paper begin, as they are now doing, to record large track programs to be undertaken by the different companies.

In considering these programs the engineers should not overlook the fact that the times just passed have served at least one good purpose in teaching the value of labor-saving devices in track construction and maintenance. Probably no other means would have taught the lesson that labor costs could be lessened, even at increased rates of wages, by the use of labor-saving machinery and tools. Having learned the lesson, it should be their plan to continue the use of such devices and at the same time to attempt an even more intensive application thereof. The fact that the labor rate is lower furnishes no reason for any let-up in the saving of labor; there are yet a number of operations in track maintenance which are ripe for the application of labor-saving methods and devices. For instance, there is room for the development of some mechanical means for loading excavated materials, such as old concrete, earth and paving materials, upon work cars following the removal of the materials from the track. Most of this work is still done manually and there must be some way to do it mechanically, in part at least, at a lower labor cost. There are, of course, many operations which will continue to require manual labor, but the slogan should be "find a way or make one" to do it mechanically."—Electric Railway Journal, Mar. 18, 1922.

Drill Steel Sharpening

Conditions and Treatment Discussed in 1921 Transactions of the American Institute of Mining and Metallurgical Engineers

By CLARENCE M. HAIGHT,
Franklin, N. J.

The general practice in drill sharpening shops of which descriptions have been written, is about as follows:

The bit is heated to a forging heat of 1,600 to 1,900° F. for a distance back from the cutting edge necessarily greater than the length of the finished bit.

After forging to the proper shape and size in the sharpening machine, the steel is allowed to cool and is then passed to a hardening furnace where the end only of the bit is heated to the critical temperature or a little higher, or to about 1,450° F., and then quenched either in cold water or brine or, as in one case, in brine with a layer of oil on the top.

If the assumption is true that, as a steel cools whether slowly or rapidly from the highest heat to which it has been subjected, it retains the grain size that corresponds to that highest temperature; then there is a condition in the bit, and also in shanks if the same process is followed, that perhaps is detrimental for the best service from the steel.

For the sake of clearness let the following assumptions be made:

That the forging temperature is 1,800° F.

That the forging operation reduces the 1,800° grain size to a size corresponding to that produced at 1,600°.

That the proper grain size desired is that produced at 1,450°.

That the bit is originally heated for 4 in. back from the cutting edge, that the hammering effect acts only to a point 3 in. back from the cutting edge, and that the hardening heat extends back only 1 in. from the cutting edge.

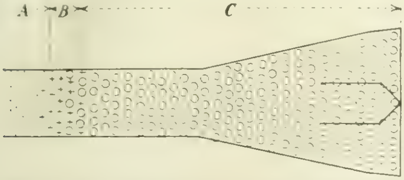


Fig. 1.—Steel as Taken from the Fire. A, Normal Size; B, Section of Change from Normal Size to 1800 F. Size; C, Size at 1800 F., 4 In. Long.

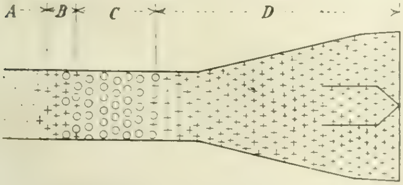


Fig. 2.—Steel After Forging. A, B and C as in Fig. 1. D, Size of Grain at 1600° F., 3 In. Long from Hammering; This Leaves C Only 1 In. Long with a Section of Change Between C and D.

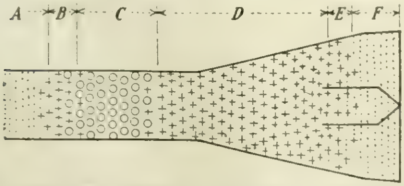


Fig. 3.—Steel After Hardening. A, B, C and D as in Fig. 2. E, Section of Change from 1600 F. Grain Size to Normal Grain Size; F, Normal Grain Size in Hardened Portion; D Has Been Reduced in Length by E and F.

Then, as a steel is taken from the fire, the grain condition is as shown in Fig. 1. After the forging operation has been performed a different condition exists, as is shown by Fig. 2. The heating operation to harden the cutting edge produces still another effect, as is shown in Fig. 3.

The questions that naturally arise from this are:

Will the cost of the extra heat treatment necessary to change this condition (annealing) be more than the saving that may be effected in the drill steel or will the extra heating be an economical as well as a wise thing to do?

Is this condition necessarily detrimental to the maximum service of the drill steel?

Can this annealing action be obtained in the hardening heat by heating more of the bit, say at least 5 in., to the hardening temperature but quenching only the end of the bit by a shallow immersion?

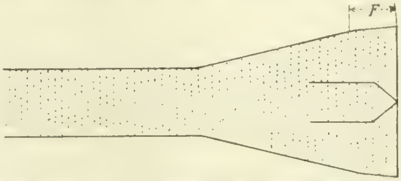


Fig. 4.—Steel as It Is Desired to Be When Ready for Use.

When taking up the question of heat treatment with the general run of mine blacksmiths, it is difficult to get them to realize the part grain sizes play in the structure of the steel and the necessity for overcoming a wrong grain if obtained. Perhaps the presentation of the matter in this way may be of assistance.

Pennsylvania Railway Official Does Not Fear Highway Competition

Abstract of an Address by Elisha Lee, Vice President, Pennsylvania System, Before the Transportation Club of New York on May 6

Our American railroads are confronted with the rise of rival transportation service. The relationship the motor car is likely to hold with respect to the railroad is beginning to define itself with a fair degree of clearness. It lies in performing a considerable portion of the short distance service, both passenger and freight.

As Henry Ford has pointed out, development of heavier cars and locomotives and longer trains on our railroads has undoubtedly detracted somewhat from the flexibility desirable in the handling of short-haul, less-than-carload traffic, but I think Mr. Ford is wrong in assuming that we should reverse the present evolution of railroads and go back to small cars and light engines, as that would rob us of the great efficiency and economy obtainable in long hauls.

In time, is it not possible we may come to look upon the motor car, motor bus and the jitney not so much as competitors of the railroads, but rather as helpful auxiliaries to the railroad service? I do not anticipate that they will ever seriously compete with the railroads for the longer hauls.

Motor bus and motor truck transportation will ultimately find their proper places in the field of distribution, and will be co-ordinated with the railroads, probably on the line of taking care of the short-haul freight. That this will ultimately be helpful to the railroads seems to be reasonable.

A passenger who rides ten miles or a ton of freight that moves thirty miles needs terminal facilities just as much as the passenger or freight shipment moving a dozen times as far. The more we increase our proportion of long distance business and decrease the proportion of short distance, the smaller becomes the terminal investment necessary for each ton-mile and each passenger-mile.

As to the possible competition of air transportation, it seems to me there is an overwhelming probability that the carrying of passengers by the air will for a very long time be restricted to a purely "de luxe" service, far out of reach of the masses.

The First Interurban Line

In the fall of 1897, Charles L. Henry, then an Indiana Congressman, built 11 miles of electric railway track between Anderson and Alexandria, Ind., and commenced the operation of it with a city car on the first day of January, 1898. He dubbed it an "Interurban Line" and thus started the modern interurban industry of the United States totaling today some 18,000 miles. Some interesting facts regarding the pioneer line are given in the March AERA, from which we have taken the matter following.

Mr. Henry is known as "the father of the Interurban," because he coined the name of "interurban" and pioneered its development. At the time he built the line from Anderson to Alexandria there was already a line operating out of Cleveland, but it had attracted little attention.

"I got the idea for the name 'interurban,'" Mr. Henry recently said, "at the Chicago World's Fair. There was a small electric line running within the Fair Grounds there, known as 'intramural,' meaning 'within walls.' Therefore, when the thought of running an electric line between cities occurred to me, I simply switched the name to the Latin 'interurban,' meaning between cities."

When Mr. Henry started his line he already foresaw that the interurban would be a distinct development of its own and would require much heavier roadway and equipment than ordinary city lines and that it would develop the handling of freight, but he was not able to foresee its rapid and very extraordinary development. He laid 60-lb. rails on the track, and while the first car operated was an ordinary city car, it was replaced as soon as they could be built, by heavier, specially built interurban cars, some of which are still in use on the lines of the Union Traction Co. of Indiana. With a view to the necessities of the future, he secured a private right-of-way for the line in preference to building it along the highway.

One of the most difficult problems which Mr. Henry faced in building his line was that of distributing electric power over the full 11 miles so that it would run cars. In those days no electric railway plants had been built except for the use of direct current from power houses. Alternating current for distribution on electric railway systems had not come into use. The result was that when the ordinary 600 volt direct current was turned into the line at Anderson, it would produce only 200 volts at Alexandria. This weakness was finally overcome by putting in a "booster," in the power house at Anderson, producing 1,200 volts there and making available 600 volts at Alexandria.

In some respects the operating of cars over the line was very crude, but in others the innovations started by Mr. Henry were so progressive that they still continue in use. The signal question was taken care of from switch to switch, but all orders were given by the dispatcher to the motorman direct in his car by means of a drop line from the telephone wire. Ever since that time on all interurban roads, orders have been dispatched by telephone and many steam roads now use this system.

The zone fare system was put in use on the line at the outset. The line was divided into three sections or zones and a 5-ct. fare was collected for each zone. At the start the road carried no freight, but it did at once carry the mail from Anderson to Alexandria. The first car was crowded and the road from the start was popular with the public.

Steam railroads, which later felt keenly the competition of the interurban, paid little attention to the interurban when it began operations. Mr. Henry found it somewhat difficult, however, to obtain co-operation when he wanted it, the steam roads declining to set cars with rails or poles for him and also refusing to permit him to cross its tracks. There was no right of eminent domain for him to take advantage of. Being a lawyer, he knew that it was entirely legal for him to cross the tracks when he was building upon a public highway and he, therefore, arranged for his road so as to have it on a public highway at every point where he wanted to cross the railroad tracks. There was no law in Indiana at the time specifically giving anyone permission to build a rural line, but Mr. Henry discovered that the state law did not permit city lines to extend their service into the country upon gaining the permission of the county commissioners, and it was on this legal ground that he built this first line and afterwards built 100 miles more of interurban road. Today, however, he says laughingly that he would not again attempt such a task surrounded by all the difficulties which had to be encountered and without the right of eminent domain.

Philip Matter, of Marion, Ind., lent Mr. Henry the first $100,000 with which to build this first interurban. This was all the money that was borrowed for that purpose, but soon after George F. McCullough, of Muncie, Ind., H. J. McGowan of Indianapolis, and Mr. Randall Morgan, of Philadelphia, were interested by Mr. Henry in the organization of the Union Traction Co. of Indiana and this group developed the present property of that name, including the line from Anderson to Alexandria. Gradually this line was extended from Alexandria to Elwood and Marion, and afterwards the line from Muncie via Anderson to Indianapolis was constructed. That company now controls 455 miles of interurban lines in Indiana and in the entire state of Indiana there are about 2,000 miles of line.

Prior to building the line from Anderson to Alexandria Mr. Henry was a practicing attorney in Anderson, Ind., for about 25 years. He also was active in real estate and business circles in the old "Gas Belt" of Northern Indiana, and became interested in local transportation in 1891, when he bought the old mule line of about five miles in length in Anderson for the purpose of extending it for factory developments. Later he electrified this line and eventually it became a part of the first interurban road. The interurban development of the country might have come quicker had not Mr. Henry become interested in politics in 1892. He then ran for Congress but was defeated. He ran again in 1894 and served two terms.

Mr. Henry now is president and general manager of the Indianapolis & Cincinnati Traction Co. This company is arranging to complete its road to Cincinnati, the downtown district of which it will reach by way of the new subway constructed in the old canal bed, thus reaching its Cincinnati terminal at what everybody knows as Fountain Square. This extension will complete the original project for the road and will add greatly to its activities.

Radio and the Principles of Invention

Of sound judgment and of especial interest in view of the wide expansion of radio activities in recent months are some remarks by Dr. Elihu Thomson made to a graduating class of the Massachusetts Institute of Technology in June, 1920.

Professor Thomson said: "Note, for example, the seemingly unlimited possibilities in wireless transmission following the creation of thermionic amplifiers, the thermionics engineering of the future. It may soon be that a station in Paris, London or Washington will talk to the whole world, and that an instrument small enough to be installed in one's study may permit us to hear what is said.

"Some untrained and uninformed minds possess the quality of originality in a considerable degree. . . . Unless tempered by sound judgment, sense of proportion and adequate knowledge, the results may be erratic. Invention in the engineering sense involves originality, but not that alone, if the results are to be of value. There is imagination more or less fertile, but with it a knowledge of what has been done before, carried perhaps by the memory, together with a sense of the present or prospective needs in art or industry.

"Necessity is not always the mother of invention. It may be prevision. As to value in invention, it is often said, and said truly, that ideas are cheap, but those which are really novel, and which will bear the cost of developing them so as to return value for the effort involved, are rare. Not all apparently good ideas, even if new, are capable of commercial development.

"Shall an invention be patented or donated to the public freely? I have known some well meaning scientific men to look askance at the patenting of inventions, as if it were a rather selfish and ungracious act, essentially unworthy. The answer is very simple. Publish an invention freely, and it will almost surely die from lack of interest in its development. It will not be developed, and the world will not be benefited. Patent it, and if valuable, it will be taken up and developed into a business."

Safety Practice for Hoisting Ropes

The Mining Section of the National Safety Council recently sent out a questionnaire to operators, regarding the class of rope used, specifications required or obtained, factors of safety observed, methods of fastening ropes, lubrication, inspection and points observed when rope is to be discarded. The answers received from this questionnaire, largely from metal mines, gave interesting information, which was summarized by R. M. Raymond in a paper presented Feb 21 at the New York meeting of the American Institute of Mining and Metallurgical Engineers. An abstract of the paper follows:

The depth in the majority of cases noted is from 1,000 ft. to 1,500 ft. and records come from a number hoisting from depths of 2,000 to 3,000 ft. Hoisting is generally done in balance, with a few companies using counterweights.

The range of loads varies from 7 to 17 tons and greater in a few cases, with a balanced weight of 4 to 7 tons

Size of Drums and Sheaves. The size of drums and size of sheaves are generally in accordance with recommendations of rope manufacturers. Only one-half of the operators use grooved drums one, the Sulphide Corpn., New South Wales, uses wood lagged drums. Very few operators have drums capable of holding all the rope in a single wrap. Cone drums or cone and cylinder drums, in the mines heard from, are very rare.

A few mines of shallow depth use a small drum and large-sized sheave. While this may be allowed, and in some cases is all right, the size of drum and sheave should be fully equal to that recommended by the rope manufacturers and should be at least 60 to 100 times the diameter of the rope used, or one thousand times the diameter of the largest wire in any of the strands.

Operations show two wraps wherever possible, and not more than three wraps on the drum; the choice of several would be not more than one wrap if possible, and not more than two as good practice. A few operators, though too few, give importance to the distance at which the engine is set from the shaft and the fleet angle between sheave and drum.

Overwind and Underwind of Ropes.—The matter of overwind and underwind of ropes perhaps receives too little attention. The experience of operators in South Africa, according to Vaughan, of the Mines Department, indicates that the rope which underwinds wears more rapidly than the overwind rope by 20 per cent, and that the average life of rope is prolonged by alternating the ropes on the drums.

In a majority of cases, sheaves are cast iron, turned out true, 1/16 or 1/8 in. larger than the size of rope used. Others use special lining of cast iron, which is removable; the best type of this is the Nordberg sheave. Several companies use hardwood blocks, preferably maple. A few use hemp packing at first or to fill the groove when the sheave becomes worn. It would seem that more attention might be given to the material of sheaves and to the question of linings.

Size of Ropes.—Ropes vary in size from 1 to 1½ in., generally 6 × 19, hemp center. A majority of the operators use the higher class rope, plow steel or special improved brands, and a few use a flattened strand, 6 × 25. A number prefer the Lang lay, which is the favorite with larger operators hoisting from the greater depths. Lang lay ropes are used in nine cases out of ten in South Africa; they are in very general use in Australia, and their use is becoming more general in this country.

Few companies stipulate specifications for rope; reliance is placed on the tensile strength given by the manufacturers. Preference is shown for plow steel by the larger operators, with the understanding that the tensile strength of the wires is, or approaches 200,000 lb. per square inch. The International Nickel Co. calls for tenders from manufacturers, gives full description of working conditions, and asks manufacturers to recommend rope for these conditions, with complete description. It requires a factor of safety of seven for hoisting ore and a factor of safety of ten for the man hoist. The United Verde mine stipulates low-phosphorus steel, high carbon and manganese, with a tensile strength of the wires of 200,000 lb. per square inch. The Copper Range Co. stipulates 1¼-in. plow steel, 6 × 19, regular lay; 58 tons tensile strength, and on test has found the rope to have a strength of 75 tons. The Broken Hill mine uses 1¼-in., 6 × 19, Lang lay and specifies a breaking stress of the rope of 60 tons and best flexible plow steel or its equivalent. The Anaconda company does not specify particularly, but uses improved plow steel in all cases.

While the manufacturers' recommendations seem to be generally satisfactory, it is most important that purchasers give clearly their working conditions, nature of shaft lining, attention given to timbers and guides, the factor of safety desired, whether mine water is acid or not, and whether harmful gases are encountered in the lower part or any portion of the mine. The rope should be stored under cover, in a cool place, properly oiled and not left on the ground

The Canadian mining law requires a certificate from the manufacturer showing date of manufacture, size, weight, number and size of wires, class of core, breaking stress of steel from which wire is made, and estimated breaking load of rope. This certificate is recorded in the "Rope Record Book" and additional data kept of operation of rope when in use at the mine.

Factor of Safety.—The factor of safety stipulated or estimated varies considerably, generally that estimated by the manufacturers in supplying rope is considered satisfactory, and is five to six for new rope. Factors of safety for worn rope vary from three and one-half to five, and these variations for discarding rope correspond somewhat with speed and depth.

None of the state laws in this country indicate any factor of safety. The Canadian mining law stipulates a factor of safety of six in shafts less than 2,000 ft. deep; and in shafts 2,000 to 3,000 ft., not less than five.

Speed of Hoisting. Speed in the shallow shafts submitted is from 600 to 1,000 ft. per min. for ore, and in deeper shafts 1,600 to 3,000 ft. per min. Speed for hoisting men in almost all cases is reduced to 400 to 600 ft., though in a few cases it runs as high as 1,000 ft. per min. Acceleration varies considerably, depending on depth. The accompanying table shows acceleration practiced by several of the important operators:

ACCELERATION IN VARIOUS MINES.

	Shaft.	Average length of haul, ft.	Maximum hoisting speed, ft. per min.	Acceleration, ft. per sec. per sec.	Length to reach max. speed, ft.	Time to reach max. speed, sec.
N. J. Zinc Co., Franklin, N. J.	Inclined	915	3,000	3.33	375	15
Inter. Nickel Co., Creighton, Ont.	Inclined	1,600	1,100	2.33	260	15
Witherbee-Sherman, Mineville, N. Y.	Inclined	1,000	1,200	1.33	150	15
Copper Range Co., Painesdale, Mich.	Inclined	1,500	2,360	2.48	130	10
Republic Iron and Steel Co., Birmingham, Ala	Inclined	5,400	2,200	1.47	159	25
Sulphide Corp., N. S. W., Australia	Vertical	825	3,650	5.06	300	15
Calumet and Arizona, Warren, Ariz.	Vertical	1,500	1,600	5.33	70	5
United Verde Copper Co., Clarksdale, Ariz.	Vertical	850	2,000	4.7	115	10
North Butte Co., Butte, Mont.	Vertical	3,600	2,700	2.53	400	17
Great Boulder Prop., Boulder, W. Va	Vertical	2,000	2,000	5.85	95	6
Old Ben Coal Corpn., Frankfort, Ill.	Vertical	475	3,600	12.00	150	5

Practice in Limiting Life of Ropes.—There is considerable diversity of practice in limiting the length of life of ropes. Several operators discard rope when the wires on the outside of the strands are worn to less than 60 per cent of the original area, and when inspection shows signs of corrosion. Others take more particular note of the number of broken wires. One company discards rope when the number of broken wires in any consecutive 10 ft. exceeds 10 per cent of the total wires in the rope; another very careful company condemns the rope when twelve wires per foot are found, or if the wires be pitted and can be pried out of place easily, even if no broken wires are found; another discards

Compared with the draft of the new mining law, the speeds for hoisting and accelerating speeds practiced by the different companies do not show any excess over the speeds recommended.

Method and frequency of inspection of ropes vary from daily inspection of terminals, including wraps remaining on drums, to weekly inspection. Fully 70 per cent of the operators make inspection daily, and one makes inspection three times a day when hoisting men.

rope when 60 to 70 wires are broken in one strand. One company finds that a decrease of ¼ in. in diameter renders the rope unserviceable and cuts grooves in the sheaves, another company abandons the rope when a decrease of 3/16 in. in diameter is shown or when seven wires are broken in any one strand. The Anaconda Copper Co. discards when not more than 20 per cent of the strength of the rope is used up by abrasion and broken wires. The Sulphide Corpn. generally discards its 6 × 7 rope when one wire in any way shows fractures; even if apparently in good condition, rope is discarded after two years' service. One iron company turns the rope end for end every six months and discards it after a use of twelve months. The International Nickel Co., which takes special care of its ropes, abandons them after two years' use, even if rope is apparently still in good condition.

Electrical Operation in Mountain District

Benefits Derived from Electrification of Main Line of Chicago, Milwaukee and St. Paul Ry., Outlined in March Milwaukee Employees Magazine

By FRANK RUSCH,

Superintendent of Motive Power, C. M. & St. P. Ry.

We are operating electrically on the main line over five mountain ranges, formerly the most difficult parts of the system, the Cascade and Saddle mountains in Washington, and the Bitter Root, Rocky and Belt ranges in Montana. On a total of about 660 route miles we have two maximum gradients of 2 per cent to 2.2 per cent for about 20 miles; **two grades of 1.6 per cent to 1.7 per cent, and several of 1 per cent.**

Loads Handled by Electric Locomotive. In freight service on grades of less than ½ per cent we can handle as much tonnage as the operating conditions will permit with one electric locomotive at speeds which may vary up to 30 miles **an hour. On 1 per cent grade ascending one electric locomotive** will handle 3,500 tons; on 2 per cent grade, 1,250 tons; on 2.2 per cent grade, 1,100 tons, all at a speed of about **15 miles an hour. We ordinarily use a helper locomotive in** freight service on mountain grades so that our average **freight trains will run about as follows:**

1 per cent grade	3,500 tons
1.4 per cent grade	3,200 tons
1.7 per cent grade	2,800 tons
2.0 per cent grade	2,500 tons
2.2 per cent grade	2,200 tons

These ratings are based on the continuous capacity of the locomotives which occurs at 15 miles an hour at full trolley pressure of 3,000 volts.

Comparison with Steam Locomotives. In making comparison with the steam locomotives that were used prior to the electrification the tonnage rating and what was actually hauled over the Rocky mountains is as follows and applies to freight trains only:

2 Mallets, Butte yard to Donald	2,500 tons
2 L engines, Butte yard to Donald	1,600 tons
2 electric, Butte yard to Donald	3,200 tons
2 Mallets, Piedmont to Donald	1,800 tons
2 L engines, Piedmont to Donald	1,400 tons
2 electric, Piedmont to Donald	2,500 tons

The tonnage hauled over this mountain is greatly in favor of the electric motors. The mountain grade from Butte Yard to Donald is 1.6 per cent and from Piedmont to Donald on the east slope is 2 per cent.

On the 2 per cent grade over the Saddle mountains in Washington two electric motors haul 2,200 tons at a speed of 15 miles an hour, whereas two Mallet engines haul 1,600 tons at a speed of about eight or ten miles an hour.

In passenger service we are not using any helper power. **These locomotives are built strong enough to handle 960** tons of passenger equipment over any portion of our track. They make good speed in ascending grades and their speed on level track is only limited by operating conditions.

In switching service we have electric locomotives at Butte, Deer Lodge and Othello. In special service we have used electric locomotives to push snow plows, on work trains and for wrecking outfits and obtained efficient results.

Some Advantages of Electrical Operation. One thing which seems of considerable importance to the steam man in first operating an electric locomotive and which is soon likely to be forgotten with other commonplace things, is that no stops are necessary for fuel or water. When you consider the delays, train troubles and extra work of watering engines, encountered in mountain traffic, you can see that the complete elimination of such is no small item in bettering train operation. When you consider that a large part of our mountain district is through comparatively dry territory the elimination of pumping plants to supply this water represents economy.

Another feature which applies to all kinds of service and of which we have good report is that although the electric locomotives weigh more on drivers than any steam power, they are easier on curved track, at least, than the steam engines. On tangent track the difference is not so apparent, but it may be stated that there have been no radical changes made in track construction since we electrified, nor has there been any apparent reason for making changes. Considering **that mountain trackage has a high percentage of curvature, this advantage of electrical operation is appreciable.**

But in order to deal specifically in bringing out advantages of electric motive power in the mountains, it will be better to go more into detail. I can perhaps do this best by considering different kinds of service separately and by giv**ing examples of actual operation.**

First in importance is the freight service in which we have reduced the number of engines required and the work of keeping them in service. We have practically reduced our running time between points by 40 per cent and have increased our tonnage in the worst districts by about the same amount. In spite of increased tonnage the drawbar reports show a decreased number of accidents of this nature after the men have become accustomed to electric operation. The **fuel consumption or kilowatt hours at the locomotive shows** marked economy and there is no doubt but that with a sufficient number of trains operating, marked economy for the whole system is possible over steam operation.

Benefits of Regenerative Braking. Freight trains can be handled over mountain grades without stopping and due to **the regenerative feature may be handled without applying** an air brake on the whole train, unless for some reason it is necessary to come to a dead stop. The regenerative braking **not only saves the brake rigging but also returns energy to** the trolley which may be utilized in helping move other **trains. Whatever may be the return on this regenerated** energy the saving made in ease of train handling with less number of break-in-twos with consequent damage and delays, is an important advantage.

The various tests on brake shoes in making a run from Avery to Harlowton show that about one-fourth of the brake shoe was worn away in controlling the speed of the trains on mountain grade, while in the westward movement between these two points it showed approximately one-fifth of the brake shoe worn away. A conservative figure on the value of the metal dissipated through brake shoe wear during a 30-day month period would be $6,000; this is not including the saving in the way of cracked wheels through overheating. Both of these items of expense have been practically eliminated through electric operation.

We expect at some future date to combine regenerative braking which sends the current back into the wire and which we have at present, with rheostatic braking which **consumes the braking energy in the starting resistors, so that** we can use electric braking at speeds down to practically a standstill. This will be a matter for experimentation.

Starting freight trains on ascending mountain grades is comparatively easy and not at all likely to result in drawbar damage. The helpers are placed in the middle of the train and the head locomotive can when starting let the slack back as far as the helper. The helper man then can advance his controller to give maximum tractive effort and is ready to **follow with the slack when the head locomotive starts. With** electric operation we have quit breaking drawbars almost entirely in the mountains.

We do not need engine watchmen with electric motive **power and at any point where one of these machines is tied** up it is only necessary for the enginemen to drop the pantographs and shut the doors and windows. This is particularly advantageous at helper tie-up points. At Butte and

Piedmont when we first electrified we had as high as six to ten steam engines, mainly required for helper service. These were replaced with two electric locomotives, which have successfully done the freight helper work since. The passenger trains not requiring helpers have to some extent made this possible of course, but this itself is also another advantage of electrical operation.

Regenerative braking makes it a decided advantage to use a helper descending a grade as well as in going up on the other side. We have only one heavy grade on the Cascade mountains where this is not applicable. Otherwise our helpers ordinarily go clear over the summits. It is common for a helper to go in a train upgrade to Boylston and down to Beverly, then back to Kittitas light with zero consumption of kilowatt hours, or regeneration in this case, making it possible to operate helpers in eastward traffic from this point at no fuel expense whatever.

The increased safety in having two locomotives in trains of this sort on heavy grades can be appreciated.

In passenger service the delays and rough handling necessary to the operation with helpers is entirely eliminated. The same locomotive which may haul the train at 50 miles per hour can also handle it with ease and certainty on a 2.2 grade.

Here again the regenerative braking feature is important. One who has tried to sleep in a passenger train through mountain districts and has been kept awake by application of brakes at frequent intervals can readily appreciate the comfort of an electrically operated mountain trip in which it is impossible to tell from the way the train is handled as to whether a grade is being ascended or descended.

The smooth handling of passenger trains is a point of merit and occasions many favorable comments from passengers about our service.

The entire absence of cinders and a certain amount of grime from coal burning locomotives is appreciated by the passengers. Complaints of delays caused by poor fuel, engine not steaming and sundry things have become things of the past. We do have our troubles with electrical failures, it is true, but these are nearly all in a class not to be called serious and fortunately are of uncommon occurrence.

Saving by Electric Switching.—In electric switching service we find that the energy or fuel expense at the locomotive has been more than cut in two over steam operation. The locomotives are quick in acceleration, easy to handle and because the engineer has little to look out for other than the operation of starting and stopping, he can lend his whole attention to the business at hand and thus gets as much work done as the yardman can attend to.

The maintenance of these machines is slight and because of taking but little energy the extra demand for power that they require is not very noticeable at the substations which furnish it.

Wherever the trolley wire goes the electric locomotive has given particularly good results. In rerailing cars or engines or pushing snow plows the uniform rate of speed for a given load and the ease with which the locomotives can be controlled make their use decidedly advantageous.

The rated tractive effort of an electric locomotive is usually given as that within the continuous or 24-hour capacity of the traction motors. This is 72,000 lb. for our freight locomotives, but does not mean very much as compared to the maximum tractive effort which the locomotive can exert. This is only limited on these machines by the slipping point of the wheels. With sand used on the rail they have been known to exert a tractive force of 160,000 lb., and this could be maintained for a period of time until the tractive motors are in danger of overheating due to the large flow of current through them. Such tractive effort makes these machines efficient in handling certain work under adverse conditions as mentioned above.

Because the tractive effort is nearly proportional to the current flowing through the motors regardless of the speed, it is very easy to judge train weights, proper ratings and other things. In fact, every electric locomotive is equipped with its own instruments so that it is a very good dynamometer itself, and in cases where the engineer runs into conditions of overloading, he can readily judge the amount and reduce as necessary. There is no argument as to whether one man can get more out of an engine of this kind than another—they are all placed on an even basis. Moreover, the normal running times are so uniform that the dispatchers, as a general rule, do not have to figure much on the personal element of the enginemen in supervising train operations.

There are possibly other benefits to be derived from electrification, but I have endeavored to stay within the limitations applying to the locomotives alone. There are disadvantages, too, of course, and there is a need for improvements and developmental changes, as is true of all electrical equipment. However, the field for experiment and such changes is large, and with the successful electric motive power we now have, we have made the start, and further improved features can be inaugurated if necessary.

Electric Haulage Systems in Mines at Butte, Mont.

Prior to 1902, tramming ore from stopes to shafts, in Butte mines, was done by man or animal power. Demand for greater tonnage and the need for more improved methods of tramming have resulted in the installation of electric haulage systems. A description of this system was given by Mr. C. D. Woodward in a paper presented Feb. 21 at the New York meeting of the American Institute of Mining and Metallurgical Engineers, an abstract of which follows:

There are now operating in the Butte mines of the Anaconda Copper Mining Co., 185 trolley-type locomotives, each of which has replaced five animals.

The haulage conditions in this company's mines have many advantageous features that are not always found in underground mine workings. The drifts and crosscuts are large, approximately 5 ft. wide by 7½ ft. high, and have curves of no less than 18 ft. radius; and the roadbeds of the drifts and crosscuts have a uniform grade of 0.5 per cent in favor of the loaded trips. In all of the mines, except two, the track gage is 18 in., and all tracks in the main haulageways are laid with 25-lb. rails. The average haul is 1,500 ft., but a number of hauls are approximately 3,000 ft. long.

Usually a train consists of ten loaded, roller-bearing cars. Each car weighs, when empty, 900 lb. and holds 14 cu. ft. of ore, which weighs about 1,800 lbs., thus the total weight of a train, without the locomotive, is 13½ tons. Normally, ten trips of ten cars of ore each are required per 8-hour shift on each mine level; this does not include, however, the tramming of waste or supplies. Waste is generally hauled during the time the ore haulage is light, as the material is usually trammed against the grade from the shaft to the stopes for back-fill. During a working day, the locomotives are in service 16 hours, hauling an average of 245 loaded cars, and returning the same number of empties.

A mine locomotive with a drawbar pull of 750 lb. would perform the work that has been outlined. To resist the abuse to which a mine locomotive is always subjected, larger equipment has been installed. The trolley locomotives now in service have a drawbar pull of 1,450 lb., a speed of 5.3 miles per hour; and weigh 3½ tons. The trolley wire is carried in an inverted wooden trough placed at one side of the tracks and made of 2 by 8-in. strips for the back and 1 by 8-in. boards on each side.

As the trolley wire is a fire hazard and a potential danger to the workmen and as it limits the use of a trolley locomotive, particularly in the gathering operation, the storage-battery locomotive has been installed in a number of the Anaconda mines. The first storage-battery locomotive put into operation demonstrated that it was a success and, as a result, thirty additional machines were purchased, and most of them are in operation. The total weight of the locomotive is 4½ tons. It is rated at 1,500-lb. drawbar pull at 3½ miles per hour on level track, with a maximum drawbar pull of 2,500 lb. for starting and accelerating.

The cost of a trolley wire and track-bonding installation on the long hauls is about equal to a set of storage batteries for a locomotive, hence there is little difference in cost between a trolley locomotive and a storage-battery locomotive installation. The cost of maintenance of the two types of installation has been in favor of the latter, as the labor necessary to keep the trolley wire in alignment with the rails, due to the movement of ground in a number of the mines, and the constant repairing of the guard strip over the trolley wire, involves a large expenditure.

There are now operating in the mines 22 storage-battery locomotives, hauling an average of 245 loaded cars and returning the same number of empties in a 16-hour day.

Research Reveals How to Ventilate the Hudson River Vehicular Tunnel

One of the most difficult problems in the design of the Hudson River vehicular tunnel was the providing of ventilation facilities. In the April issue of the Compressed Air Magazine Mr. Robert G. Skerrett describes how experiments were conducted to determine the amount of fresh air required, the means of propulsion and transmission, and other factors involved in order to insure against any physical discomfort occurring to anyone using the tunnel. An abstract of the article follows:

The Hudson River vehicular tunnel will consist fundamentally of two cast iron tubes, each of a maximum diameter of 29 ft., lying 60 ft. below the surface of the water at mean low tide, and having a span from portal to portal of fully 8,500 ft. When first ready for service, the daily traffic will involve the movement of approximately 17,000 conveyances, most of which will undoubtedly be of an automotive character. By the end of the sixth year the vehicular tide will be made up of the to-and-fro passage of substantially 24,000 vehicles in the course of 24 hours, and by that time the percentage of self-driven cars and trucks will have increased to a marked degree: By 1940, it is computed that the tubes will be used on an average daily by something like 56,000 conveyances, among which the horse-drawn vehicle will be less and less in evidence.

It is obvious, from the figures cited, that a ´steadily augmenting volume of noxious gases will have to be dealt with. Mr. Clifford M. Holland, Chief Engineer, and his technical associates of the joint New York and New Jersey Tunnel Commission have been keenly alive from the very start to this vital aspect of their problem; and the burden placed upon them has been all the heavier because very little helpful data could be obtained from the practical operations of other under-water vehicular tunnels.

As these engineers pointed out a year ago, the usual method employed in ventilating railroad tunnels, for instance, is to blow fresh air through the viaduct from end to end—forcing the air in at one portal and allowing it to escape at the other. To ventilate the twin tubes of the Hudson River vehicular tunnel in this fashion would require a very large volume of circulating air and would entail excessive air velocities along the roadways, especially at points near the supply nozzles. Modifications of this system, in which shafts were to be utilized to shorten the distance between the intake and the exhaust portals, were considered, but this arrangement, in itself, was found unsuited and not likely to radically better conditions.

Finally, after considerable deliberation, the engineers of the commission settled broadly upon a scheme which would introduce fresh air into each tube through a number of openings leading from a supply duct—this passage to be separated from the roadway, and carry off the tainted air by another duct of a kindred character. This disposition of ducts promised to avoid excessive air velocities and likewise to insure throughout the length of each tube a uniform distribution of fresh air and a corresponding withdrawal of the atmosphere admixed with hurtful gases. Certain experiments made in 1916 seemed to indicate that it would probably be advisable to place the fresh air duct below the roadway and the exhaust duct above the ceiling, and this arrangement was tentatively agreed upon until further tests could be made, to settle this question.

The authorities wisely decided to clear up all of the ventilating problems by practical tests carried out in ways and upon such scales as would furnish conclusive data. This research work has been finished, and in its successful prosecution has called for a total outlay of $80,000.

The Scope of the Investigations. These investigations have been manifold in their nature, and have supplied information which will be of outstanding value in a number of fields of engineering. Indeed some of the results directly contradict previously accepted theories. The first two lines of inquiry had to do with the character and quantity of the exhaust gases generated by internal combustion engines when running and with the physiological effects of certain components of these gaseous mixtures, particularly carbon monoxide.

The purposes of the latter research were to ascertain how human beings and animals would react when breathing for different intervals an atmosphere polluted with various proportions of carbon monoxide. The desire was to determine how long such admixtures could be inhaled without injury to health, and to establish the maximum of carbon monoxide that might be carried into the body the while without harming even persons of feeble constitution.

Inasmuch as the questions for investigation were closely allied with the proper ventilation of many mining undertakings, the U. S. Bureau of Mines collaborated with the Tunnel Commission. Road tests with 101 motor vehicles, including representative types of passenger cars and trucks, were conducted by the U. S. Bureau of Mines at the Pittsburgh Experiment Station, in accordance with a program laid out by Mr. Holland. These tests extended over an interval of ten months, beginning in December of one year and ending on the last of September succeeding, thus covering both winter and summer operating conditions.

Test of Motor Vehicles at Pittsburgh. The cars used were taken at random from those offered by private individuals, corporations, and automobile dealers of Pittsburgh; and under the circumstances the results may be considered fairly typical of motor vehicles actually running on the streets at divers speeds and upon changing grades. No alterations of carbureters or other adjustments were made; and the cars and trucks contended with physical situations much like those which will exist in the two tubes. As a result of these tests it was discovered that the average volume of carbon monoxide produced was considerably higher than previously computed. This meant that the ventilating plant would probably have to deliver more fresh air into each tube than had originally been deemed necessary. Here was a revelation that potentially entailed a larger blower equipment and a heavier annual outlay for electric power.

Yale Tests on Effect of Carbon Monoxide.—Happily, physiological inquiries at New Haven led to disclosures that offset the findings at Pittsburgh. This work was conducted at Yale University under the supervision of Professor Yandell Henderson, acting pro tem for the U. S. Bureau of Mines and indirectly for the Tunnel Commission. It was recognized by this physiologist that, inasmuch as the ventilation of the tunnel ought to be ample enough to obviate not only danger but even slight discomfort to persons in transit, his function was to ascertain the maximum permissible absorption of carbon monoxide by the body within the limit just mentioned. Prior to this investigation at Yale there was no precise definition of allowable vitiation of the air by admixture with carbon monoxide.

At first, it might appear that the ventilation of any closed space should be such as to insure air quite as pure as that of the city streets; and had this standard been adopted there would have been no need for research, for a basis of one part of carbon monoxide in 10,000 parts of air might have been accepted at once. This was impracticable, with tubes having a length of 3,800 ft. between ventilating shafts, unless the "blow-through" system was employed, which would demand an air stream moving from end to end of the tunnel at a speed of 30 miles an hour! The tunnel engineers had earlier estimated that it would not be unsafe for passengers in the tubes to breathe an atmosphere containing three parts of carbon monoxide in 10,000 parts of air; and they had planned that the atmosphere in each tube should be changed completely at regular intervals of 90 seconds. Even so, it was recognized that the ventilating plant would have to be made up of 65 electrically-actuated blowers, ranging from 20 to 300 Hp. each; and this equipment was sure to call for heavy annual expenditures for operating current. Professor Henderson, after exhaustive experiments on human beings and animals, proved that a still higher percentage of carbon monoxide could be inhaled without inconvenience or hurt for a much longer time than would be required to make the journey through the tunnel at the very slowest pace.

In one series of tests, the subject was placed in a compartment that could be made airtight and which had a capacity of 226 cu. ft.; in the second series a chamber having a capacity of 12,000 cu. ft. of air was employed. In this was installed a Ford car and several persons were exposed to the variably vitiated atmosphere. When the small compartment was used, measured amounts of pure carbon monoxide were introduced after a subject had entered, and at different intervals the latter shoved his hand through a self-sealing elastic panel so as to facilitate the withdrawal of blood for analysis. Persons submitting themselves for test spent periods of one hour in an atmosphere containing from two to eight, and in one case ten, parts of carbon monoxide in 10,000 parts of air. While they sat and read most of the time, there were a sufficient number of acts—such as turning on an electric fan to insure a thorough diffusion of the gas, standing up to look out of the window for a moment, opening and closing flasks to take air samples for later examination, etc., to correspond fairly well with the activity of a driver of a car.

Blood, to the amount of 20 or 30 drops, was drawn from a finger before the volunteer entered the chamber, and .02 cubic centimeter was similarly obtained at the middle of the period and at the end, and usually once or twice during the succeeding three hours. These samples of blood were analyzed for carbon monoxide. After leaving the compartment the subjects were put through various tests to ascertain the effects of the inhaled carbon monoxide. It appears that no one had an appreciable degree of headache after remaining one hour in the chamber, during which the atmosphere contained four parts carbon monoxide or less. With six parts, the effect, if any, was usually very slight. With eight parts there was decided discomfort for some hours, although not enough to interfere with efficient work in the laboratory or at the desk. After an hour, with ten parts, even an exceptionally resistant individual was rather miserable; averse to effort for five or six hours; and could still feel the effects after half a day.

In the case of the experiments in the larger chamber, where the air was tainted by the actual exhaust of an automobile, the disclosures in no wise differed radically from those already referred to; and the net result of the findings was that men, women, and children—including infants and invalids—not to mention soldiers, who might have to march through the tunnel, could in perfect safety breathe for an hour an atmosphere admixed with four parts of carbon monoxide. Tests with dogs and horses revealed a kindred measure of immunity. The researches at Yale, while minimizing the disquieting motor-vehicle investigations at Pittsburgh did not, however, completely neutralize the possible consequences of the unexpectedly large propagation of noxious gas by cars and trucks, and the question still remained whether or not ample ventilation could be assured without increasing the proposed blower installation of the air distributing system. The settlement of this problem directly concerned the annual cost of operation. An answer to this query was obtained in a thoroughly practical manner by a second series of investigations.

The Expense to University of Illinois.—The first of these studies was pursued at the Engineering Experiment Station of the University of Illinois under the supervision of Professor A. C. Willard and in accordance with a program prescribed by Mr. Holland. There was built at Urbana a half-size trial-duct 300 ft. long. This duct was constructed of reinforced concrete and timber, and was patterned along the lines planned for the full-sized duct designed to be located beneath the roadway of each of the tunnel tubes. Under the terms of the contract entered into with the University, the work at Urbana was to deal specifically with the following subjects: first, the determination of the coefficient of friction of air flowing in concrete ducts such as were proposed for the vehicular tunnel; second, the verification of formulae used in computing the power required for moving air through a duct from which air would be drawn off at designated intervals; and, third, the measurement of power losses due to bends in flues, ducts, or airways.

During the earlier tests the farther end of the duct was generally closed and the exhaust air reached the outside atmosphere via the side ports. Under this condition the duct, simulated the proposed method of ventilating the vehicular tubes. That is to say, the ventilating ducts in either of the tubes are not intended to furnish an uninterrupted flow of inbound and outbound air from portal to portal. These ducts will be blocked by bulkheads at the center of the river; and the blower equipment on each bank will therefore take care of only half of the length of the tunnel. Such being the case, the primary experiments were devoted to ascertaining whether it would be feasible to get a fairly uniform supply of air at all points of the duct, and this at pressures that would not be markedly different at stations close to the blower and at those remote from it. It was thought that the first and the middle sections of the duct would have enough air but that the third or last section might show a deficient flow. Contrary to expectations, the most distant stretch of he conduit gave an ample discharge, and this was discovered to be due to the back pressure built up in that area, while the middle division fared worse despite the shorter distance from the fan. This meant that the outlets in the middle section of the duct would have to be larger than those in the third one in order to provide the required volume of fresh air to effect the needful dilution of motor gases throughout the corresponding part of the actual tunnel. This disclosure contradicted the commonly accepted theory applicable to similar cases.

The foregoing researches emphasize not only the errors of prevailing formulae but establish the fact that the coefficient of friction usually employed in connection with the flow of air in concrete ducts, etc., was about 100 per cent too high. This was a heartening discovery. Previous data had been secured by somewhat modest laboratory investigations, while the scale of the duct used at Urbana was large enough to prevent the mistaken deductions of earlier workers in the field.

Another line of inquiry had to do with the evolution of a type of expansion chamber which would best serve to insure the widest dispersion of fresh air in the neighborhood of the tunnel roadways. Twenty-five different models of expansion chambers were tested at the Urbana Engineering Experiment Station before one was evolved which would give satisfactory diffusion. The accepted pattern is so shaped that air issuing from it at a velocity of 1,000 feet per minute has no appreciable force at a distance of but 5 ft. away, and yet the impulse will carry the air quite to the middle of the driveway. In other words, the fresh air entering from each flank of the tube will meet in the center of the cross-section and provide complete circulation.

The concluding studies at Urbana were directed to determining power losses due to blowing air through the bends of flues, etc., and with this in view full-sized elbows of several sorts were tentatively tried out before erecting a combination elbow at the far end of the 300-foot duct. This elbow represented a union such as will be formed where the vehicular tunnel tubes join the four ventilating shafts through which fresh air will be fed downward and foul air will be drawn off and sent aloft to the free atmosphere. In the elbow the air is obliged to make two turns, each of 90 degrees, and it was important that the change of route should not invite any needlessly increased resistance.

There is a well-recognized law that the inner or short radius of a duct shall be equal to the diameter of that passageway. This could not be subscribed to and the desired result realized because of the large diameter of the elbow. The area of that conduit was bound to induce a high coefficient of friction by reason of the lessened velocity of the air stream threading its way through the compound turn. As the textbooks tell us, the coefficient of friction varies with the velocity—i. e., the greater the velocity the lower the coefficient of friction. The technicists solved the problem by interposing a vane or longitudinal partition in the airshaft; and by this agency the single passageway was transformed into two, each of them having a short radius such as would meet the theoretical requirements. This divisioning caused the air to rush more rapidly through the tortuous channels; and the added velocity so diminished the frictional resistance that the impulse power was reduced at the elbow by quite 25 per cent.

Tests at Pittsburgh for Determining Methods of Introducing Fresh Air.—The researches at Urbana, together with the finding at Yale, completely counterbalanced the rather discouraging revelations of the motor-vehicle gas tests at Pittsburgh; and the only ventilating question still awaiting settlement was whether the fresh air should be fed up into the tubes from ducts below the roadways or downward from similar conduits overhead. Once more the tunnel engineers sought the aid of Government experts. Opinions differed as to where the supply and the discharge ducts should be located; and there was much logic in the argument that the engine gases could be disposed of quickest and by the shortest route if they were carried off near their points of origin—i. e., by exhaust ducts running beneath the floors of the tubes.

In order to approximate the subterranean circumstances that will characterize the Hudson River vehicular tunnel, a test tunnel, 130 feet below ground, was utilized. This tunnel, nearly oval in form, was constructed at Bruceton, Pa., in the experimental coal mine of the U. S. Bureau of Mines, and was the result of uniting two existing parallel drifts by curved terminal galleries. Within this tunnel, which has an axial length of 400 feet, was built a timber and reinforced driveway having a rectangular cross section 9 ft. wide and 7½ ft. between the floor and the ceiling. Underlying the floor is a duct 4 ft. high and above the ceiling there is another conduit 5 ft. high, and arrangements were made by which either duct could be used at will for exhaust or supply purposes.

At eight stations set 50 ft. apart on one of the straight sections of the underground speedway, were hung at different elevations groups of sampling tubes. These were connected by piping with a central station whence air from all of them could be pumped. An interval of half an hour was needed to fill the sampling tubes for testing. The number of motor cars run during the investigations ranged from one to eight, and each of these vehicles also carried sampling tubes—one on top, one at the driver's feet, and a third intermediate between these extremes. The automobiles were driven uniformly at a rate of 10 miles an hour. Chauffeurs and passengers were subjected to examination before and after every trip by physicians and physiologists; and the machines were operated for one hour periods. Besides exhaust-gas sampling apparatus, each motor was provided with gasoline measuring facilities; and there were air sampling tubes interposed in the exhaust duct at one station, where samples were taken continuously to determine the make-up of the air as it left the tunnel. In brief, care was taken to guard against any possible errors through a comprehensive counterchecking system; and it was practicable to determine the composition of the air at any vertical or longitudinal point in the tunnel.

All told, seventeen ventilating experiments were made at Bruceton, six of them with the fresh air reaching the driveway from overhead and eleven of them with the fresh air issuing from the duct beneath the floor. During these, two runs were made with one car, two with three cars, five with four cars, and eight with eight cars. While it was ascertained that there was apparently no striking difference between upward or downward admission of fresh air, what difference existed was in favor of upward circulation. Further, the developed structural features of the tunnel made the latter course more desirable. On the other hand, the physiologists found that the absorption of carbon monoxide by the blood was less with the rising movement of the air than with the descending flow, the percentage of CO in the atmosphere being the same in both cases.

Carbon monoxide, at atmospheric temperatures, is a trifle lighter than the air, and the total average of all the exhaust gases from a motor car—at equal temperature, is also somewhat lighter than the air. Therefore, the hot engine exhaust has a pronounced tendency to ascend when discharged. This is accelerated by the eddy or partial vacuum at the rear of an advancing car and is further stimulated by an inrush of fresh air impelled ceilingward from low-lying expansion chambers. In other words, the noxious gases in the vehicular tunnel will thus be swept toward the ceiling and got rid of before they will have a chance to diffuse and to contaminate seriously the continually changing atmosphere.

The underground tunnel at Bruceton had a heating plant, and being 1,050 ft. in from the pit mouth of the mine it was practicable to maintain reasonably uniform temperatures, and to reproduce at will conditions substantially identical with those that will prevail at various seasons within the tubes that are to be driven beneath the Hudson River. It is well worth stressing the fact that the comprehensive inquiries described settle not only how best and most economically to ventilate the tunnel in question but they provide data of great value for many other engineering undertakings and show wherein the technical manuals of today err.

An aggregate of 6,500 H.P. will be required to operate the blowers when the tubes are used to capacity, and this will insure a movement in both of these subaqueous driveways of an average total of 3,500,000 cu. ft. of air per minute. The flow of air on the upgrades will be at the rate of 293 cu. ft. per minute per foot of tunnel, the stream on the downgrades will have a volume of 125 cu. ft. per linear foot of tube, and on the level portion of the tunnel the air will have a tide of 225 cu. ft. per minute. This distribution will suffice to prevent the dilution of gas exceeding four parts of carbon monoxide in 10,000 parts of air.

New Method of Culvert Construction, on the Pennsylvania Railroad

The following interesting account of the construction of a culvert with no interference with traffic is taken from the Railway Maintenance Engineer for January.

Railroad culverts are, as a rule, constructed under existing tracks by two general methods, which consist of excavating and of tunneling. A departure from these methods was recently carried out on the Pennsylvania Railroad near Maurer, N. J., without interruption of traffic or the use of any slow orders. In this work two 20-ft. cylinders made of ⅜-in. boiler plate, each 6 ft. 6 in. in diameter, were jacked through the embankment beneath the double track line, thus taking the place of the usual excavating and cribbing operations.

In carrying out this construction a working space was first excavated at one side of the tracks, sufficiently large to allow the first cylinder or shell to be placed in position for jacking. Four 25-ton, worm-gear drive jacks, manufactured by the McKiernan-Terry Drill Company, New York, were used. A U-shaped frame built up from 12-in. by 12-in. timbers joined with tie plates was installed as a bearing surface for three of the four jacks.

Jacking Shield Into Embankment.

The bearing provided to rest against the back of the excavation opposite the shell consisted of 4-in. yellow pine vertical sheeting with three lines of 12-in. by 12-in. timbers placed horizontally on either side of it. Work was advanced 10 in. at a time, that being the full extension of the jacks, after which the length of the jacking timbers was increased and the performance repeated. The upper part of the shell was jacked through stiff clay and hardpan and the lower part through quicksand. The average progress was about 3½ lin. ft. in a 9-hr. day. It was estimated that there was a load of about 50 tons on each of the jacks during the work. The top of the shell was kept about four feet below the top of rail, and the arch of the shell was found to be sufficiently strong to support the passage of the heaviest trains. After the jacking through was completed the interior of the shell was excavated and 48 in. by 52½ in. Massey concrete pipe was installed and the space between the pipe and the shell filled with grout.

The work was done by Arnolt More, Inc., Newark, N. J., under the supervision of F. M. Arnolt, who, with J. G. Forman, inspector, developed the underlying idea.

A French Automatic, Air Operated Shovel for Various Uses*

At a recent meeting of the Sociétéde l'Industrie Minérale, M Claper described a simple form of automatic shovel, driven by compressed air, for filling coal stowing waste, and other analogous operations. The compressed air acts as a sort of "servo-motor" for raising and tipping the bucket, the latter being directly manipulated by the workman. A chain

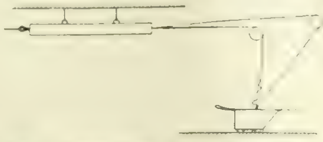


Fig 1—Shovel With Vertical Rope Slack.

attached to a piston driven by compressed air after passing over a pulley placed above the loading point, is hooked on to the bucket. The motor itself comprises a simple tube, 62 mm. in diameter and 285 mm in length, which can quickly be slung in whatever position is required. It weighs, all told, about 57 kg. The stroke varies from 1.20 m to 1.50 m. A small piston equipped with a recoil spring is placed at the rear of the cylinder. Control is exercised by the movement of the chain, a relatively small tension on this compressing the spring of the piston, called the auto-exciter, and causing a relative displacement of the piston with respect to the ports of the cylinder, thus allowing the air to be admitted on the front of the motor piston. The load when raised remains suspended by the air pressure, the tension exercised on the chain maintaining the spring of the distribution piston compressed and the air inlet open. As soon as the bucket is emptied, this tension becomes insufficient to maintan the requisite pressure on the spring of the piston, and the air is exhausted, while the inlet is closed, thus causing the bucket to fall again to the ground.

The bucket may take different forms, according to the material to be loaded, and the base may be replaced by a fork or grid. The workman pushes the bucket into the pile and rakes the material into the same, afterwards giving a slight tug to the chain. By the modification shown in Fig. 2, further economy of labor may be secured. In the first instance, the vertical chain being slack, the bucket, under the action of the oblique chain swings over the ground and penetrates the mass. As soon as the vertical chain becomes taut, it is raised, describing a hyperbola.

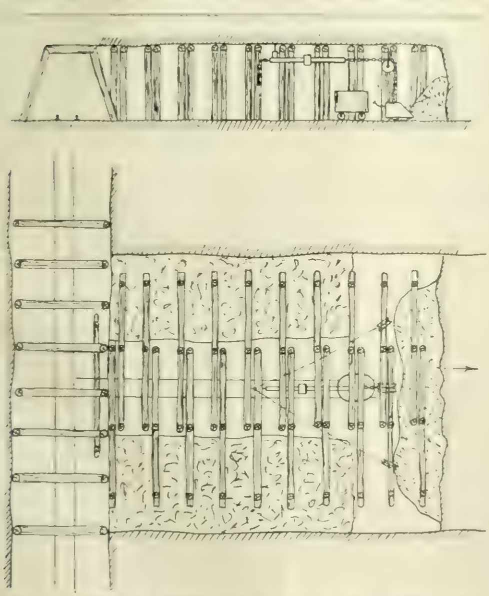


Fig. 2—Position for Raising Bucket With Vertical Chain Taut.

Tests of the appliance have been carried out in a thick seam at Montrambert, and by means of it a youth of sixteen has been able to fill without fatigue an average of 40 tubs per day over a period of several months. Each bucketful weighs about 60 kg., and the complete operation takes about 25 seconds, thus in three minutes a tub of 420 kg can be fully loaded a result that may be attained by hand, but not without excessive labor. In practice, it is stated that the output per workman has been doubled, and as many as 80 tubs have been filled per day. For operation in the open air the appliance is suspended from an improvised jib crane, consisting of a balk of timber slung from a trestle and mounted on a wheelbase.

The consumption of compressed air amounts to about five litres at 5 kg. for each bucket load, 35 litres per tram load or about 14 cm. per day, or about a twenty-fifth or thirtieth of the power required to drive a pick machine to get the equivalent quantity of coal. Above ground it has an important advantage over the steam shovel, owing to the low first cost.

Transportation Problems Confronting the American People*

Outline of the Situation and Its Requirements Given in a Paper Read Before the Engineers' Club of Philadelphia

By EMORY R. JOHNSON,

Professor of Transportation and Commerce, and Dean of the Wharton School of Finance and Commerce, University of Pennsylvania

I am speaking upon a theme concerning which we are all more or less in doubt, and I am quite certain there is nobody here who would assert that he has a solution for the transportation problem, and certainly not a solution for the present American railway transportation problem. And yet I do not speak as a pessimist. I am by temperament one who looks at life hopefully, and I look upon the present transportation question as an optimist; and I am not that type of optimist I heard defined not so long ago, as a man who didn't care what happened so long as it didn't happen to him. Now, I do not want you to be pessimists when I finish,—because I heard a definition of a pessimist which was rather significant. That definition was, that the pessimist is a man who has spent some time with an optimist.

I spoke two or three weeks ago on this question, before the American Philosophical Society, and I had the unique experience of being followed immediately, in discussion, by a man who took the other side of what I had said, and he was none other than Doctor Wiley, the celebrated food expert; and, judging from what I see going on before me, there are numerous food experts here, and there possibly may be a number who would agree with Doctor Wiley in what he said at the meeting of the American Philosophical Society.

I might open my address by stating three facts which I think we must accept at the outset of any discussion of the railroad transportation problem:

Three Important Facts.—The first fact as to railroad transportation which we must get over and cannot go around is that the business of the country and the progress or stagnation of the nation depend upon the strength and growth of the railroads and other agencies of transportation. Transportation development sets the limit of national progress.

It took the great war, with its tremendous disturbance of economic and social conditions, to bring home to the American people the fact that the progress of the country is determined definitely by the strength and efficiency and progressiveness of our railroad system. Almost up to the war the public attitude toward the railroads had been one of curbing abuses and eliminating that which was wrong. It had been an attitude of restraint. Now the public realizes that the railroad system must be promoted by wise measures.

The second obvious fact is that probably forty per cent of the railroad mileage in this country is owned by companies that are at the present time virtually insolvent. Even the larger companies are in financial difficulties. The Pennsylvania Railroad, to the regret of many of us, but wisely as I must admit, has reduced its dividend, for its own revenues today would not justify the four per cent which it has temporarily decided to pay. I do not believe that situation is permanent, but it is a real situation, and even the strongest railroads of the United States are today in a most unsatisfactory condition.

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*From The Compressed Air Magazine.

*Luncheon address, May 3, 1921, The Engineers' Club of Philadelphia.

The third equally obvious fact is that the only way to work out the problem of railroad transportation successfully is by adhering to private ownership and operation. If the people of this country become discouraged or confused and bewildered, and adopt government ownership and operation of the railroads they will gradually but surely pass into a state of coma and over industry will slowly come a creeping paralysis. I do not believe you men believe in government ownership of the railroads.

Requirements of the Present Situation. If any group of thoughtful men and women were asked what is just now the biggest or most serious railroad problem, the majority would doubtless say it is the problem of reducing the costs of operation, and particularly labor costs, while it is also probable that the majority of the group thus questioned would reply that the next largest railroad problem of the hour is how to secure from private investors the billion dollars a year needed to reconstitute and develop the railroads of the country.

After stating in this manner the two outstanding problems of the hour, and I think I have before me an exceptional group of men, because many of you engineers deal with these questions profoundly, I believe a group of men such as you would enumerate at least five other specific requirements of the present railroad situation, and if I mistake not, you would enumerate the following points:

First, the necessity for the federal control of both intra and interstate railroad rates. This is an immediate problem calling for prompt action on the part of the States. Practically all of the States have united in a case now pending before the Supreme Court. By this case it is to be determined whether the United States has power to control intra-state rates that affect interstate commerce. The Supreme Court approved a decision giving the Interstate Commerce Commission the power to set aside an intra-state rate that discriminates against an interstate rate. In deciding the case now pending before the Supreme Court, it is to be hoped, and is expected, that the Supreme Court will uphold the power of the federal government. If it should so hold, it will give power to the federal government to control the revenues of the railroads of this country. Ten per cent of the increase allowed by the Interstate Commerce Commission to the carriers last August was not received because of the effect of the State laws and Commission rules.

The second point is the consolidation of railroads in accordance with the plan worked out and promulgated by the Interstate Commerce Commission. Railroad consolidation is certain to come. I am not sure it will come quickly. I rather hope it may. But it must come, because it is certain that the systems that constitute some forty per cent of the railroads in this country must be eliminated; their insolvent condition makes them a burden to their stronger brothers and to the public. Every part of this great country must be served by a strong railroad system. The country demands it.

Grouping of Systems. The only way the weak systems can be effectively eliminated is by the grouping of the railroads of this country into a limited number of systems of approximately equal strength and stability. The Act of 1920 gives the Interstate Commerce Commission the mandate to work out a plan. When the plan has been adopted and promulgated by the Commission, individual consolidations may take place in accordance with that general plan and with the approval of the Commission, voluntarily. If that doesn't work, then I think that we will have to resort to compulsory consolidation of railroads in accordance with the plan developed by the federal government. Consolidation means a better schedule of rates; it means better transportation for a larger section of the country; it means a better railroad system for the future. This is a problem of the near future, of the next ten years.

Third, the federal incorporation of all railroads engaged in interstate commerce and the consequent subordination of the railroads as corporations to the United States Government. Federal incorporation should run on all fours with consolidation. It, thus, also becomes a problem of the next ten years.

It is inconceivable that the fifteen to twenty-five great railroad systems of the future, these permanent, consolidated systems of which I have spoken, should be subject to the individual states. They should legally be federal corporations, and by making them such the railroads will be benefited and the public will be served better.

The fourth problem is the development of executive machinery for the constructive regulation of railroads and for the development of a unified system of transportation by railroads, highways, waterways and possibly by airways. This is a problem of the next twenty-five years, during which period all the agencies and facilities of transportation should be welded together into a unified system serving all parts of the country with maximum economy and efficiency. This problem of executive machinery may not seem to you important, but railroad regulation has long since ceased to be primarily a semi-judicial problem. There remains yet the semi-judicial problem of rate regulation, which will be exercised, as far as the federal government is concerned, by the Interstate Commerce Commission; but the regulation must be constructive, and there must be administrative and executive machinery. To make that regulation helpful, executive or administrative machinery must be provided. The Interstate Commerce Commission consisting of eleven men—semi-judicial in temperament, training and environment—does not constitute a body for effective executive or administrative action. In my judgment a Transportation Board of not more than five men, possibly three men would be better, should be created, with power to bring about the coordinated development of railroads, highways, waterways and airways.

Economies of Operation.—The fifth point is as follows: The introduction wherever possible of economies in the operation of railroads. Our transportation systems, which have developed under conditions of enforced competition, include many duplications of facilities, particularly in large terminals. By coördinating terminal facilities and by operating them as a unit in each large terminal area, it will be possible to reduce the expenses both of the carriers and of the shippers. It should be the policy of the government to facilitate all efforts of carriers to bring about the common use and joint development of terminal facilities. The Interstate Commerce Commission by the Transportation Act of 1920 has been given two significant powers: (1) The joint use of terminals as, for instance, the joint use of the Pennsylvania terminal by the Baltimore & Ohio and the Pennsylvania railroads. It can thus permit or compel several railroads to use the same terminal. (2) It also has the power to bring about the common development of future terminal facilities, because the Commission must pass upon security issues, for when railroad corporations apply to the Commission for permission to issue a security for the development of a certain terminal, if the Commission is of the opinion that several carriers should cooperate in that development it can refuse to permit the issue of such security until such carriers do unite. It has the power, then, under the Act of 1920 to bring about a greater degree of unification under private operation and construction. Its authority should be fully exercised, and if experience should show that additional powers are needed by the Commission, such powers should be granted.

Summary of the Situation. From this brief statement of the main requirements of the present railroad situation, the following diagnosis may be made of the present railroad transportation problems confronting the American people:

The cost of operating and of extending the railroads must be brought down, and this can be accomplished only (1) when the railroad executives regain control over the management of their business. To some extent they have such control of the management of their business, but from the days of the Adamson law there has been a decreasing control by them over their own properties. The railroads have been returned to their owners under conditions which make discipline, economy and efficiency extremely difficult. I am of that old school which believes that we cannot have efficient and economic transportation unless the railroad companies be given the authority to determine their own policies for the operation of their properties. I do not mean the federal government should not have a large share of control over employers and employes, but that control should stop short of reducing the power of the company to enforce discipline in the management of its affairs.

(2) Another factor in the cost of extending and operating the railroads is the reduction in the costs of supplies, equipment and new plant. These should be made as low as moderate profits on the part of producers will permit. This reduction in the cost of railway supplies, equipment and plant may be expected to accompany the return of industry to more normal conditions.

The revenues of the carriers must be maintained. The hampering laws and commission rulings of the several states as to intrastate rates must give way whenever the laws and regulations interfere with the unified regulations of railroads by the federal government. Moreover, present rates, though confessedly higher than they ought permanently to be, must be maintained at least until the traffic of the railroads shall return to normal, as it will return gradually with a resumption of the building trades, the construction of roads and bridges and the renewed activity of manufacturing industries. If voluntary consolidation does not work out, we may be obliged—we shall be obliged—to resort to compulsory consolidation.

Both the government and the great body of investors must facilitate the carriers in securing the added amount of capital necessary to rehabilitate the railroads of the country. The government regulation of security issues must be made as helpful as possible. The government must make the promptest possible payment to the carriers of the four hundred million dollars it now owes them, and what is especially important, the banks and buyers of securities must keep their faith in American railroads. Capital can come only from private or governmental sources. If we permit it to come from governmental sources, we shall run the risk of fastening upon the country the government ownership of the railroads.

The government should proceed promptly with the formulation and publication of plans for the grouping of railroads into a limited number of competitive systems of comparatively equal strength, and the railroads should be encouraged in every way practicable to carry out these plans for consolidation.

And, finally, in dealing with this complicated railroad question—with its labor problem, its financial difficulties, and the intricacies of government regulation of rates and service we should all keep our heads level and keep them cool. We should retain full faith in the future of this great country, in its industrial development, in the progress of our railroads, and the continued dominance of those moral and spiritual forces that have made us successful in the past and will make us triumphant in the future.

Valuations by New York Transit Commission Protested by Companies and Security Holders as Grossly Inadequate*

The tentative valuation recently submitted by the New York Transit Commission for the various traction properties in New York City ("Chronicle" of Feb. 25, p. 803, and detailed table herewith) preparatory to the adoption of a plan for the merger of the city's transit facilities, has met with an emphatic and impressive volume of protests from the various companies and committees of security holders most closely interested. These replies are summarized below.

Since prepared in most instances either by or under the supervision of eminent counsel, these statements possess more than passing importance, and they make it plain that however much the interests concerned might like to unite in furthering the merger plan for the public good, they stand in positions of trust which compel a stout contest against anything like confiscation. The reader will note, also, that many of the companies report a greatly improved financial outlook.

Interborough Rapid Transit Co.—Excerpts from Statement by President Frank Hedley, March 20.

Up to June 30, 1921, the cost to the company of the construction and equipment of the new subways and elevated improvements amounted to	$149,525,099
The Bureau of Valuation reports that the value of the identical property as of June 30, 1921, is	138,209,830
Difference between actual cost and reported value	$ 11,315,269

As the greater part of the expenditures were made before the excessively high prices due to the war the present value of the property is greatly in excess of its actual cost instead of being over $11,000,000 less than cost as reported

If the same property were to be reproduced today it would cost not less than $200,000,000

The time allowed for analysis of the valuation report has been too short for exact results but it would seem as if this difference of $11,315,269 is made up of items which may be put into three classes:

Depreciation	$ 3,384,013
Chief engineer's deductions from company costs	3,543,751
Discount and expense	1,387,504
Total	$11,315,269

The alleged depreciation seems to be calculated on a theoretical or socalled straight line basis having no relation to the actual condition of the property.

The company denies that the property has depreciated in value and alleges on the contrary that its value has appreciated

The chief engineer's deductions are also objected to and unless less modified upon a re-determination will have to be submitted to arbitration before an impartial board, as provided in the contracts.

The matter of depreciation will also have to be arbitrated as provided in the contracts. The company cannot consent to have either of these questions "tried out" by the Transit Commission, as your letter of Feb. 23, 1922, states that you purpose doing upon receipt of objections. It is not consistent with fairness to permit a party to be the judge in his own case. It was for this reason that the contracts carefully provided for arbitration.

As to the discount and expense of procuring the money which the valuation bureau has deducted, the company objects on the ground that the bureau has apparently fallen into error in assuming that it should ascertain present value according to the formula named in dual contract for acquisition of the property by the city at the end of the first ten years of operation or thereafter, in which case the city must pay 115% of the "net cost" in money of the property or a gradually diminishing percentage each year after the tenth year.

That premium was contracted to cover, among other things, the discount and expense of procuring the money above the "net cost" allowed by the contracts, and it is absurd to propose to take the property after only 3¼ years of operation without making provision to cover this discount and expense.

To ask investors who within the past three years have bought $38,144,400 of the company notes, and within the five years prior to that bought $162,106,000 of bonds, to accept less than par and interest savors so much of repudiation by the City of New York that it is inconceivable that the Commission will find itself able to adopt the valuations its bureau placed upon the property provided under the contracts of March 19, 1913.

The Commission consented to the sale of $52,615,000 of the new bonds to refund the investment of the company in the original subways. The exact figures agreed to by the city experts were $48,339,515 as of Dec. 31, 1912. But the 1922 report cuts this down to $43,898,479 before depreciation—a reduction of over $4,000,000, and on top of this cut is a further reduction for alleged depreciation aggregating $7,887,251, leaving as the valuation of the entire property of the company in the old subways $36,011,228 as of June 30, 1921.

The actual cost of these properties as shown by the books of the company is $62,655,243. The allowance of $48,000,000 in 1912 was for tangible property only. If 30% be added as the usual percentage to cover the intangible costs above mentioned, the property was worth in 1912 its book cost of $62,655,243. It has not depreciated in value since 1912. On the contrary its cost to reproduce at the present time would approximate $100,000,000. It must be remembered that the cost of the old subway was incurred during a period of low-price levels.

From the foreging it appears that the present value of the property in question is at least $300,000,000 instead of $174,221,058 reported by your Bureau of Valuation.

Other assets not appraised by your bureau but which are represented by the capital stock of the company increase the present value of the entire assets of the company to a sum greatly in excess of $300,000,000. Yet your reported valuation would not be sufficient to pay par on the outstanding bonds and notes, thus leaving nothing whatever for the stock.

It must be remembered that the contracts of 1913 contemplated that this company would earn from its subway operations alone a return of approximately 9% on its stock. It has been calculated that the present worth of the rights under the subway contracts alone is in excess of $70,000,000, or over twice the par value of the stock.

This company understands that the Manhattan Railway Co will file a statement of its own views concerning the reported

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*Greatly condensed from a statement and summaries given in the Commercial and Financial Chronicle, March 25, 1922.

[illegible] the proposed elevated railroad [illegible] the Interborough [illegible].

[illegible] Supreme Court of the United States.

[illegible] the subway [illegible] the existing [illegible].

Excerpts from Protest by Interborough-Metropolitan Co. 4½% Bondholders' Protective Committee March 18.

[illegible] proposed new [illegible] Bonds [illegible] representing the properties [illegible] the properties as [illegible] your Commission.

[illegible] of the properties of the Interborough and Manhattan companies proposed by your Valuation Bureau would [illegible] for the issue of a [illegible] of the new [illegible] to provide for the securities [illegible] of the Interborough Rapid Transit Company's [illegible].

[illegible] from the following computation:

Interborough and Manhattan bonds and notes outstanding, exclusive of Interborough bonds in the sinking fund	$237,797,400
Aggregate valuation of the Interborough and Manhattan properties on the basis recommended by your Valuation Bureau (estimated original cost less amount assumed to be necessary to place the properties in first class operating condition)	228,595,261
[illegible] the amount by which the aggregate valuation fails to provide for the outstanding bonds and notes	$ 9,202,139

[illegible] the most liberal basis (estimated reproduction cost of the Manhattan lines at 1921 prices less depreciation) the aggregate valuation proposed by your Valuation Bureau is only $238,[illegible]. This valuation exceeds the aggregate amount of the Interborough and Manhattan bonds and notes outstanding by only $[illegible].

Regarding the appraisals of the properties of the New York Railways Co. system whose stock is owned by the Interborough Consolidated Corporation, it is enough to say that the aggregate of the valuations of your Valuation Bureau on the basis recommended by it is $29,871,787, which is less than half of the amount of the bonds and other obligations resting on the properties which aggregate about $[illegible].

The reorganization we have in view should make it easier for the owners of the Interborough property to cooperate with your Commission in solving the city's transit problem and you may feel assured that we shall at all times be ready to discuss any arrangement with the public authorities that will adequately protect the securities we represent.

Excerpts from Digest of Statement by Alfred Skitt, President Manhattan (Elevated) Railway.

As you know, the Manhattan Railway Co. has engaged Messrs. Coverdale & Colpitts, independent engineers not otherwise employed by Manhattan Railway Co., to make a report of the valuation of the properties of the Manhattan Railway Co.; these engineers [illegible] engaged contemporaneously with the engineers employed by the Bureau of Valuation in examining the properties and in preparing a report of their value. Messrs. Coverdale & Colpitts have completed their examination and have made a report to the Manhattan Co.

[illegible] advise the company that the valuation of the properties of the company made by the engineers representing the Bureau of Valuation of the Transit Commission is so erroneous [illegible] the supporting data upon which the [illegible] are based that the valuation found by the [illegible] represent the fair [illegible] cost of the properties of the Manhattan Co. less depreciation.

The Bureau of Valuation found the [illegible] estimated original cost of the properties of the Manhattan Railway to be as follows:

[illegible]	$52,417,138
Less amount necessary to place property in first class operating condition	1,042,932
[illegible]	$51,374,206

[illegible] Bureau of Valuation [illegible] the company actually paid [illegible] the fact that the [illegible] of original cost [illegible] $2,[illegible] on this item, eliminating $1,0[illegible] out of the amount actually paid.

The Bureau is attempting to find the fair reconstruction cost less depreciation. It may use original cost only as evidence bearing upon the reconstruction cost, but while purporting to use the original cost it refuses to accept the amount actually paid notwithstanding that if the railroad of the Manhattan Co. were to be constructed today the easements could not be secured in any case except by the payment of a sum far in excess of the $2,[illegible]153 actually paid by the company.

Excerpts from New York Railways Adjustment Income Bondholders' Committee, Statement of March 17.

The Valuations Submitted.—Our examination of the valuations made for the Commission has been the more attentive because of our sympathy with efforts to solve the transit problems of this city by some method which would meet the public need of service without confiscating the property of the security holders of the various corporations involved.

In no event could we consent to a valuation theory which is based on conditions of many years ago now non-existent. That such a theory is inapplicable to the results to be reached in solving the problem before us appears to be recognized by the valuation engineer who has valued the land owned in fee at its market value as of June 30, 1921. We do not understand why land should be valued at modern prices while the other constituents of the system assumed to exist as they were originally purchased or constructed from 20 to [illegible] years ago are valued as if they were worth no more now than such things cost in the last century.

Valuations for purchase ought to be based on principles not more injurious to the owners of property than those employed in the exercise of other similar governmental powers. At least as many times of value should be [illegible] in a "purchase case" as are commonly considered in a rate case (Denver vs. Denver Union Water Co., 246 U. S. 178, 1[illegible]) and both in purchase cases and in the rate cases "the value of the property is to be determined as of the time when the inquiry is made" (Willcox vs. Consolidated Gas Co., 212 U. S. 19, 52).

In the Minnesota Rate Case, 230 U. S. 352, the Supreme Court said: "The property is held in private ownership and it is that property, and not the original cost of it, of which the owner may not be deprived without due process of law."

The law in this respect is not arbitrary; it accords with common sense and economic truths. Where the prices of all articles and properties of every character advance to the tremendous extent which the prices of [illegible] have done over those of 1880 and where commodities of every kind share this price-advance on substantially equal terms, and it is evident that the values of steel rails, electrical apparatus and other equipment of the New York Railways System have not advanced substantially more than the prices of food, clothing, and other necessaries, then it is clear that the value of a particular commodity has not changed as compared with the values of other commodities, but that the value of the dollar has fallen measured in the terms of all commodities. It takes no more steel and no more labor to produce a rail now than it did in 1880; more dollars are necessary to pay for the rail because the value of the dollar has declined.

It follows that payment in present-day dollars must be made at present-day prices because those prices are made by the exchange value of the present day dollar.

Nor could we justify ourselves to the security holders whom we represent in bargaining away the properties in which they are interested at less than the condemnation value of those properties.

Of the 5% Adjustment Mortgage bonds of the New York Railways Co. $8,765,000 are held by savings banks, life insurance companies, charitable institutions and other semi-public corporations, and $19,845,000 are held by 2,[illegible] individual investors, an average holding of less than $10,000 apiece.

According to the method of valuing properties in this country as prescribed in the opinions of the Supreme Court of the United States and as customarily followed in practice, the present value of the operating properties comprising the so-called New York Railways System (including the Fourth, Eighth and Ninth Avenue lines) as of June 30, 1921, on the data provided by the Valuation Bureau itself appears to be the figure of $75,579,196. The data underlying that figure we shall be glad to investigate as soon as we are assured that such a method of valuation is seriously to be considered. (The committee arrives at the figure named by deducting from the gross valuation of the operating properties of the system on the basis of 1921 prices, namely $90,756,122 as reported by the Commission, the amount—$15,176,926—stated by the Commission to be required to place the system in good operating condition.

[On the basis of "original cost" less the sum of $15,176,926 the Commission values the system at $29,871,787.—Ed.]

Second Ave. R. R.—Receiver Considers Property Much Undervalued.

I have examined the report of the engineer and accountant setting forth their estimate of the valuation of this property and find they have greatly undervalued the same.

Some of the many items that have been undervalued are the [illegible] of car barns and the real estate of this railroad upon which you do not allow as much as the assessed value placed thereon by the City of New York for tax purposes. This property, in accordance with its earning capacity, as evidenced by the rental received therefor, should be valued for at least $2,000,000.

Excerpts from Brooklyn Rapid Transit Co. Digest of Stockholders' Protest March 18.

As a committee organized to protect the interests of the stockholders of Brooklyn Rapid Transit Co., we represent a class of investors numbering more than 10,000 individuals owning in the aggregate over $74,000,000 of stock, all of whom have invested in good faith in properties which embrace upwards of 700 miles of track and which have always been considered to possess great value. For more than three years, these properties have been in receivership, mortgages securing bond issues are in process of foreclosure, the operation of the railroads has been continued under most trying conditions, and the stockholders are properly concerned with any suggestion emanating from a responsible official body bearing upon the future of their properties.

Upon the execution of the contract in March, 1913, the company proceeded promptly and faithfully to carry out its part of the bargain to the very letter. The stockholders did their part in placing the company in a position to finance its obligations under the contract by authorizing a mortgage on their rapid transit and other properties to secure $60,000,000 of obligations which were issued and sold to provide the necessary funds for the construction and equipment of the company's share of the new lines.

Every dollar of this money was expended by the company under the direct supervision and control of the Public Service Commission and its successors, and notwithstanding the rising prices and other unanticipated burdens imposed by the World War, the company's part of the work proceeded with the utmost dispatch.

On the other hand, the city has unreasonably and without just cause delayed the construction of important lines which it undertook to construct with due diligence, and even now, nine years after the contract was made, the 14th St. East New York Line, from a revenue and service standpoint, one of the most important, has not only not been completed, but substantial portions have not been placed under contract; and the construction of the Nassau St. Loop, the use of which we are advised would effect very substantial operating economies and thus materially increase the revenue of the properties, has not even been begun. These delays and refusals of the city constitute violations of the contract, which we are advised are very largely responsible for the present predicament of these properties.

The operating ratio of the rapid transit lines, which, in your report to the Board of Estimate in May, 1912, you estimated would not in any event exceed 50% for the enlarged system, amounted to 73.22% for the fiscal year ending June 30, 1919, to 82.23% in 1920, and to 94.43% in 1921, as shown by the tables annexed to the report of your Bureau of Valuations. This increase was due not only to the economic conditions prevailing generally, but, to a very large extent, to the failure and delay on the part of the city to complete the lines to be constructed by it.

Your engineers state that they have endeavored to ascertain actual or original cost and that, where this has not been ascertainable, they have "estimated" the same on various theoretical assumptions as to conditions under which the properties should have been constructed. Apparently, however, no real effort has been made to check the actual investment, especially with respect to the older properties. In this manner, an unfair impression has been given the public, and both your Commission and the public may be grossly deceived thereby.

The actual investment in B. R. T. system exceeds $238,000,000. This does not include any value for franchises, nor does it include a large amount chargeable for interest during construction, appreciation of real estate over original cost and other items which would very substantially increase the above amount.

As opposed to this actual investment, which is $10,000,000 in excess of the net capitalization of the B. R. T. System outstanding in the hands of the public Dec. 31, 1921, your engineers propose to allow, on the basis of their theoretical assumptions as to "actual" or "original" cost, only $154,000,000, or a difference of $84,000,000. This recommendation is obviously so unfair as to afford no basis for discussion.

The outstanding debt against these properties including the underlying bonds, notes and bonds issued since 1913, with interest in default, receivers' certificates, tort claims and other obligations, is estimated at over $135,000,000, approximately $78,000,000 of which has been expended since 1913 under the direct supervision and control of your Commission or your predecessors in authority.

To provide for this debt of over $135,000,000, your engineers recommend a valuation of approximately $96,000,000, or $39,000,000 less than enough to provide for the debt, thus eliminating completely all stockholders' equities in the properties. In reaching this valuation, your engineers have placed a net value of approximately $22,400,000 on the company's extensive elevated railroad system in the Borough of Brooklyn, which was given an earning power under the contract with the city of $3,500,000 per annum, which, capitalized at 5% (the rate proposed under your plan), would support a value of at least $70,000,000 for the property.

In conclusion, we would call your attention to the fact that the earning power of these properties has shown marked improvement during the current fiscal year. Conditions are beginning to return to normal. The average operating ratio (including taxes) of the surface lines has been reduced from 97.15% in 1921 to about 78% for the first seven months of the current year, and the operating ratio (including taxes) of the rapid transit lines has similarly been reduced from 94.43% to about 75%.

The company has a contract with the city which it has lived up to under most trying conditions, but which the city has flagrantly and deliberately violated. The performance by the city of its obligations under the contract, with just compensation for past defaults, which we are advised should be at least $20,000,000, would permit the receivership to be terminated at once, and we propose to request the Court and its Receiver to take all steps appropriate to enforce the company's rights in this connection.

Nassau Electric R. R. Committee for First Consols Dissents (Condensed) March 20.

The value of the properties of the Nassau Electric R. R. Co. recommended by the Bureau of Valuation is $8,227,529. If bonds for this amount should be issued under your plan for the Nassau properties there would remain for the holders of the $11,508,000 of Consols, to represent the principal amount of such bonds and the $1,380,960 of interest accrued thereon, after payment with the new bonds at par of all bonds, accrued interest, receiver's certificates and other claims having priority over the Consolidated Bonds, less than $4,000,000 of the bonds you propose to issue.

In other words, the holders of the Consolidated Bonds would receive in the new 5% bonds less than 35% of the principal amount of their bonds, and nothing whatsoever on account of accrued interest.

Other protests quoted in the original article but omitted from this condensation were filed by the following organizations:

New York Railways—First Real Estate and Refunding Mortgage Committee.

Lexington Ave. and Pavonia Ferry R. R.—Protective Committee for First Mortgage 5s.

Eighth Avenue R. R. Co.

New York and Harlem R. R. Surface Lines.

Third Avenue Ry.—S. W. Huff, Pres.

Brooklyn Rapid Transit Co.—Bankers' Committee.

Brooklyn City R. R.

Coney Island and Brooklyn R. R. Co.—Bondholders' Protective Committee.

Brooklyn Queens Co. & Suburban R. R.—Consol. Bondholders' Committee.

Why Old Railroad Ties Are Burned

The question as to why worn-out crossties are burned by railroads instead of allowing people to take them for fuel has been answered by Samuel Porcher, general purchasing agent of the Pennsylvania Railroad, in which he states that efforts have been made to interest dealers in firewood in buying the old ties, but thus far without much success. The causes appear to be that the old ties are often dirty; that they contain stone, grit and slag wedged in the cracks which might injure the saws used in cutting them; that in many cases they are partly decayed; that they are dried out and that their fiber is more or less crushed, so that they burn out quickly. For these reasons dealers have been unwilling to pay the railroad company enough to cover the cost of collecting the ties and delivering them to a point at which they could be removed.

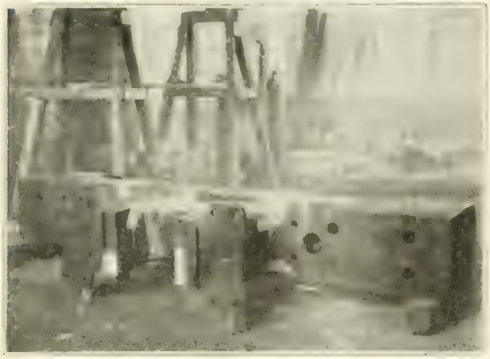
Efforts have also been made to dispose of old ties in such ways as for wood pulp purposes, for extraction of chemicals, for burning and sale of the ashes for fertilizer, and for manufacture into charcoal, but without success.

Some ties have been sold to purchasers living on or near the right of way who buy them at nominal prices, usually at from 10 to 15 cents apiece. Such means of disposal is practicable only where the ties can be delivered at a public crossing or other points so that they can be obtained safely by the user and where the cost of delivering them is not greater than the nominal prices obtainable. The company feels that it cannot allow the public to go promiscuously over its tracks and through the yards to gather up old ties, as this would be practically letting down the bars against trespassing on the tracks, an evil against which the Pennsylvania Railroad has struggled for years and which has been the cause of about half the fatal accidents on railroads in the United States.—Electric Railway Journal.

Steam Shovel Casting Gas Welded

The steam shovel is a heavy duty device and is constructed to stand up under severe working stresses. Even so it is not uncommon for some working part to give way in the racking service to which the mechanism is put, and at such a time the necessity for quick yet efficient repairs is most pressing.

The end sill casting for a large steam shovel repaired by oxy-acetylene welding is shown in the illustrations. It is a hollow steel casting about 8 ft. long, 3 ft. high and from 16 in. to 20 in. wide, with walls 1½ in. thick. The casting recently cracked in a dozen or more places when subjected to an overstrain. Some of the pieces were small fragments that broke out and were lost. Like the old shay of the rhyme, it had done yeoman service only to give way everywhere at once.



Casting in the Shop With Breaks Marked.

To replace the broken casting with a new one would have kept the equipment idle for several weeks. In the emergency the cracked and broken casting was shipped to the Oxweld Acetylene Company, Newark, N. J., and was repaired by welding in that company's job shop. It was promptly shipped back and was immediately returned to service, more than saving the cost of the repair in the time gained over replacement delay.

Permissible Wear of Rail Heads on Interurban Lines

(a) What in your opinion should be considered the safe limit of wear on head of rails used on interurban lines, expressed in terms of per cent of the total head area, before rails should be renewed? (b) What factors control such wear limit?

The above questions and the following series of answers from operating officials were printed in the May issue of Aera.

E. D. Echrood, General Superintendent of Ways and Structures, Northern Ohio Traction & Light Co., Akron, O.—Maximum of 30 per cent. The wearing limit being controlled by the weight of equipment in service or the ability of the rail to withstand stress placed upon it.

J. S. Hyatt, Engineer, Maintenance of Way, Chicago, North Shore & Milwaukee Railroad, Highwood, Ill.—(a) On high speed main line, rails should be renewed after they show wear of 15 per cent of head area. On branch lines and slow speed track a wear of 25 per cent of head area is considered safe. (b) The wear limit is controlled by amount of traffic, weight of traffic and speed.

S. Cleo Baker, Engineer, Maintenance of Way, East St. Louis & Suburban Ry. Co., East St. Louis, Mo.—(a) Approximately 33⅓ per cent. (b) The factors controlling such wear limit are curved or tangent track, speed of cars, weight of cars and whether or not guard rail is used if on a curve. Have observed curve worn rails to approximately 40 per cent of head area but do not consider them safe. These were on curves of sufficient radius that guard rail was not necessary. In all cases of curve worn rails close supervision is necessary that track may be kept at correct gage.

Geo. H. Harris, Assistant to General Manager, San Francisco-Oakland Terminal Rys., Oakland, Cal.—(a) Fifty per cent approximately. (b) Difficulty of maintaining alignment and gage.

W. L. Wilson, Chief Engineer, Maintenance of Way and Structures, Des Moines City Ry. Co., Des Moines, Ia.—(a) About 25 per cent. (b) Weight of rail (new) and amount and character of traffic.

W. F. Graves, Chief Engineer, Montreal Tramways Co., Montreal, Canada.—(a) Thirty-five per cent under ordinary interurban traffic. (b) Speed and weight of cars, foundation of track and the condition.

Edward M. Graham, President, Bangor Ry. & Electric Co., Bangor, Me.—(a) Under certain conditions as much as 50 per cent of the rail head can be considered as the safe limit of wear on interurban lines where cars as light as 28,000 lbs., and rails as heavy as 80 lb. tee are used and the speed is not excessive. (b) Factors controlling such wear limit are as follows: (1) Weight of section, (2) weight of cars; (3) speed of cars; (4) welding of joints.

C. A. Smith, Superintendent of Roadway, Georgia Ry. & Power Co., Atlanta, Ga.—Seventy per cent on curves. On straight line the limit would be somewhat less than this, due to the fact that the rail would become unsuitable for high speed traffic before this limit was reached, due to surface bending of rails and failure of joints.

Comment by Special Engineer, American Electric Railway Association.

The above answers indicate that there is quite a range of permissible wear of rail heads, depending on whether straight track or curves are being considered, and on the amount, weight and speed of traffic using the rails. This matter having been studied by the Committee on Way Matters of the Engineering Association in 1921, the following references are given for those who wish to inquire further into the subject.

Proceedings American Electric Railway Engineering Association, 1921, pages 84-86 and 99-107.

Also see Electric Railway Journal, July 31, 1915, article by Mr. E. M. Haas.

Personals

Frank McCune, general manager of the Monongahela Connecting R. R., has resigned. His successor has not been appointed.

H. T. Bently was on May 1 appointed general superintendent of motive power and machinery of the Chicago & Northwestern Ry.

F. H. Fuller, assistant engineer, Northern Pacific Ry., formerly working from Pasco, Wash., is transferred to Spokane office.

Graham W. Curtis is appointed industrial commissioner for Eastern Lines, Canadian Pacific Railway, succeeding H. P. Timmerman, retired.

J. P. Carey, until recently superintendent of the Nebraska Division of the Union Pacific Ry., has been transferred and made superintendent of the Los Angeles Division.

Joseph S. Goodwin and **Ross Schram** are, respectively, general manager and assistant general manager of the newly amalgamated city and company street car lines of Detroit.

Robert Quayle, general superintendent of motive power and machinery of the Chicago & Northwestern Ry., after fifty-four years of service with that company, has asked that he be retired.

Geo. Harries, civil engineer, has been decorated by Secretary of the Navy Denby with the Navy Distinguished Service Cross. During the war Mr. Harries served with the United States Army.

Ralph Modjeski, consulting engineer, and the firm of Modjeski & Angier announce the removal of their Chicago offices to new quarters at 28 E. Jackson Boulevard. This will be their address after May 1, 1922.

Frank D. Danielson, a civil engineer, took office as village manager of Hinsdale, Ill., on April 1 this year. Mr. Danielson has charge of all departments of the village, including water, electric light and ice plants.

E. E. Mayo, formerly division engineer of the Southern Pacific Company's Portland division at Portland, has been transferred to the same position on the Sacramento division, with headquarters at Sacramento, Calif. H. A. [illegible], formerly assistant division engineer at Portland, succeeds Mayo.

Obituaries

William R. Allen of [illegible], Mass., a civil engineer, died on May 8. He was a graduate of University of Pennsylvania, class of 1897. He was connected with the Bethlehem Shipbuilding Corporation during the World War.

J. P. McDonald, said to have built as many miles of railroad track as any contractor in this country, died at Knoxville, Tenn., on May 9, at the age of [illegible]. Most of his work was done for the New York Central. In [illegible] he built [illegible] miles of track with [illegible] tunnels in the Island of Jamaica for the British Government, and he constructed the line in Ecuador from Guayaquil to Quito.

Col. Clement A. F. Flagler, [illegible] officer of the Eastern Division, United States Engineers, died on May 7 at Johns Hopkins Hospital. He was [illegible] years old. During the World War Col. Flagler commanded the artillery of the Fifth Division, afterward being promoted to the rank of major general and placed in command of the Third Division artillery. He saw service in the St. Mihiel and Meuse-Argonne campaigns, and for a time after the signing of the armistice he commanded the famous Rainbow Division in the Army of Occupation in Germany. While overseas he was decorated with the Croix de Guerre and the medal of the Legion of Honor.

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Roads and Streets—1st Wednesday
(a) Roads
(b) Quarries and Pits
(c) Streets
(d) Street cleaning

Waterworks and Hydraulics—2nd Wednesday
(a) Water Works
(b) Irrigation and Drainage
(c) Sewers and Sanitation
(d) Waterways
(e) Quarries and Pits for Ballast and Concrete

Railways—3rd Wednesday
(a) Steam Railway Construction and Maintenance
(b) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures

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The Real Magnitude of the Building Boom

Few people realize the magnitude of the building boom that is now in progress. During the first half of 1920 building construction was back to the pre-war normal, but the business depression that started just two years ago caused a great decrease in building operation. The building revival started last September, and is now in full swing. Table I gives the total building contracts awarded in 27 northeastern states, as compiled by the F. W. Dodge Co.:

TABLE I—BUILDING CONTRACTS AWARDED IN 27 STATES.

	1920.	1921.	1922.
January	$193,098,000	$ 87,422,000	$147,585,000
February	165,633,000	82,130,000	156,280,000
March	243,721,000	130,134,000	241,639,000
April	241,101,000	172,843,000	277,841,000

Since building costs were about 40 per cent higher in April, 1920, than in April, 1922, it follows that the volume of building was 50 per cent greater this April than two years ago.

Although the number of square feet of floor space is not a very accurate gauge of building construction in abnormal years, still it serves roughly to indicate relative building activity. The total floor area in square feet corresponding to the above given values of contracts is as follows for April of each of the three years:

	Sq. ft.
April, 1920	50,962,000
April, 1921	34,471,000
April, 1922	58,146,000

For the year 1913 the monthly average of total construction contracts awarded in the 27 states was $71,475,000 including public works contracts. Since public works contracts usually average in value about 20 per cent of the total construction contracts reported by the F. W. Dodge Co., it is probable that the monthly average of building contracts in the 27 states was about $57,000,000 in 1913. Building construction costs are now about 75 per cent above the costs in 1913, so that at present prices the monthly average of building contracts awarded in the 27 states in 1913 would have been $100,000,000. Contrasting that $100,000,000 average with the $278,000,000 of building construction contracts awarded last month in the 27 states gives a pretty clear conception of the true magnitude of the building boom.

The Commercial and Financial Chronicle publishes periodic statements of building permits in 286 cities, thus covering practically every city having a population of more than 25,000, or 70 per cent of the total urban population. Table II is from the April 29 issue of The Chronicle.

The recent abnormal increase in building operations in New York City is attributable not only to the housing congestion that occurred during the war, but to the existence

To Our Subscribers:

Owing to our increased business and circulation, our circulation department has found it advisable to install an entire new addressing and mailing system, operated upon the most modern methods and with the latest and most efficient mechanical equipment to be had.

This change of system, which has been under way for some six weeks and is now almost completed, involves more labor and more difficulties than are probably realized by most readers unfamiliar with such matters; and during its progress there are inevitable errors and delays in correspondence, changes of address, new orders, etc.

With any of these annoyances by which you may have been affected we ask you to be patient; but at the same time kindly to inform us of any errors which you wish rectified or of any continuance of such errors.

ENGINEERING AND CONTRACTING.

of a law that exempts new buildings from taxation for ten years.

The boom in Los Angeles is largely attributable, we think, to a great advertising campaign. The slogan of real estate men, contractors and bankers alike has been, in essence, "Own Your Own Home." Freedom from labor troubles has also contributed greatly to the Los Angeles boom. In fact that city is an example of what can be accomplished under industrial freedom when energetic business men are at the helm.

TABLE II—VALUE OF BUILDING PERMITS

Year	No. cities	New York	[illegible] cities	Total all
1921	280	$ 476,287,104	$ 1,[illegible]	$ 1,866,267,135
1920	286	240,828,412	1,[illegible]	1,60[illegible]
1919	286	261,[illegible]	1,[illegible]	1,[illegible]
1918	280	[illegible]	[illegible]	[illegible],128,037
1917	280	103,068,798	[illegible]	820,[illegible]
1916	285	221,[illegible]	919,[illegible]	1,140,[illegible]
1915	284	152,945,720	778,941,580	931,[illegible]
1914	284	138,11[illegible],266	753,730,258	891,841,524
1913	233	162,912,28[illegible]	818,025,278	980,937,563
1912	[illegible]	228,601,308	798,914,875	1,027,515,183
1911	235	200,325,288	762,174,380	962,499,668
1910	223	217,818,617	761,398,183	979,216,800
1909	209	273,108,030	[illegible]	1,013,785,972
1908	206	174,757,619	555,324,252	730,081,871
1907	200	197,618,715	604,[illegible]	802,290,151
1906	162	241,064,458	564,486,823	805,551,281
Total 16 years		$3,413,511,627	$13,148,711,065	$16,562,222,692

	Los Angeles	Chicago		Los Angeles	Chicago
1921	$82,[illegible]	$125,004,510	1914	$1[illegible],361,925	$ 83,[illegible]
1920	60,[illegible]	76,173,150	1913	31,641,921	89,521,970
1919	28,253,619	104,198,850	1912	31,367,995	88,198,600
1918	8,678,862	35,131,150	1911	23,004,185	105,269,700
1917	16,932,082	64,188,750	1910	21,684,100	96,932,700
1916	15,036,945	112,835,150	1909	13,260,703	90,559,580
1915	11,888,662	97,291,480			

Note: The building cost index, or relative building cost, of the Associated General Contractors, is as follows: Year, 1913, 100 per cent; 1914, 98; 1915, 98; 1916, 108; 1917, 128; 1918, 143; 1919, 171; 1920, 237; 1921, 189; Dec., 1921, 185.

The New "Index" of Building Material Prices

The U. S. Bureau of Labor publishes monthly an "index" of building material prices which shows the general price level of building materials. Hitherto steel has not been included among the materials whose weighted average prices have been used in calculating the building material price index. But hereafter structural steel is to be included. Excluding structural steel and a few other building materials the building materials price index for April was 201, as compared with 100 for the year 1913. But including structural steel and other important building materials not hitherto included, the price index for April, 1922, is 156.

The difference between 201 and 156 is so great as to make it certain that the entire difference it not attributable to the inclusion of structural steel. It is true that the "weighting" hitherto used has been based on the quantities of building materials produced in 1909, whereas hereafter the "weighting" is to be based on the production in 1919. But no change in "weighting" accounts for so great a change in the index price. We have written for a statement in detail of the materials and their "weighting," so that in our next Building and Structural issue we shall be able to give all the reasons why the building materials price index has been changed so radically.

As shown elsewhere in this issue the wholesale price index of all commodities was 152 in April of this year as compared with 154 a year ago.

Standard Contract Form for Indiana Architects.—The State Accounting Department of Indiana has completed a standard contract form to be used between public officials who contract for public work and architects. One of the first provisions of the contract is that the public official shall prepare a certified statement showing the indebtedness and constitutional debt limit of the employing unit. The architect is obligated to ascertain or have the state accounting department ascertain the correctness of the statement or the architect's fee may not be collected. The form prescribes how the architect's fees shall be collected but does not state the percentages of the fees, his being left to local arrangements. Twelve articles constitute the provisions of the contract and many of them work into the law merely the present requirements of the laws on the subject.

Are the Coal Miners Demanding the Hindu "Caste System?"

If a hundred educated men were asked to state the fundamental cause of our remarkable economic progress of the past century, probably more than 70 would reply that to science must be given the credit. But is there not a cause back of science itself? Is science not an effect of a cause that we of today are prone to forget?

Whoever has read of the persecutions of the early scientists can scarcely have failed to be impressed by the fact that science thrives only in an atmosphere of freedom. Wherever individual opinion and initiative have been suppressed, progress has been suppressed. In many countries we still find an almost complete mental slavery of the people. In India the slavery is that of the caste system. In China it is also that of social customs and religion. From such fossil societies may we not infer that it was repression of individual freedom that held science in check for 20 centuries after the early Greeks began the systematic study of nature?

It has often been pointed out by historians that Greek science came into existence only after Greece had freed itself from the bondage of a pagan religion.

Individual freedom and rapid economic progress have always been associated, and in the absence of individual freedom there has never been rapid economic progress. This much history has taught so clearly that few will question the generalization.

Constraint is usually of a social kind, and where it has been of long duration it is not apt to be regarded as objectionable. Customs relating to dress, for example, are not often objected to by individuals, no matter how detrimental to health they may be. Similarly, if a man has been brought up to regard it as inevitable that he shall always follow the trade that his father has followed, that man is not apt to rebel against the social custom that really makes him a slave. So we need not marvel that the caste system of India and the labor union systems of Europe and America rarely cause the men brought up in those systems to regard themselves as in any way deprived of liberty.

There is food for thought in the following utterance of the editor of the Financial Chronicle:

"But is it not true that unionism and organization looking chiefly to wages does so segregate and so bind employes to the single industry, section and plant, and by this concert of will and action tends to destroy their individual liberty to seek severally other employment where the hope and promise of greater equality of enjoyment exists? The dignity and value of all work are enhanced by the free embracement of our unbounded opportunities in a free life.

"We do not attempt to apply this strictly to the present as to any 'strike.' We seek to develop the principle that the workman in a free civilization must seek to advance himself educationally, spiritually, if we may use the term in contra to the physical, as well as financially: namely, the securement of higher wages with which to buy equality of enjoyment. The very spectacle of 600,000 men engaged in a single industry voluntarily retiring from work at the same time, with no idea of seeking other employment permanently for betterment (possibly for better or for worse) shows an utter disregard for the benefits of free opportunity, shows their willingness to be miners underground for life—unless they can secure arbitrary wages commensurate with their preconceived proper "cost of living." If all men would form themselves into these enslaved classes the very mobility of advance would be destroyed, opportunity in a changing, eager, aspiring life would be negatived, and wages and profits would become like the frozen hammocks of the sea, forever uneven and impossible of equalization."

While we are not in accord with one of the underlying thoughts in the foregoing paragraph, namely, that the 600,000 coal miners show a willingness to be miners for life, still we do believe that very few of them realize that they are slaves to a system that tends to retard progress. They fail to see that insisting on a 6-hour day with a view to giving permanent jobs to 200,000 men who are not needed as miners, they are virtually endorsing the caste system of India, and asking America to abandon the principle of individual freedom under which this country has attained its economic pre-eminence.

Index Numbers of Wholesale Prices 1913 to April, 1922

The accompanying tabulation shows the index number of wholesale prices by groups of commodities, as computed by the U. S. Bureau of Labor Statistics. The group of miscellaneous commodities includes such important articles as cottonseed meal and oil, lubricating oil, jute, rubber, newsprint and wrapping paper, rope, soap, laundry, starch, tobacco, Manila hemp, sisal, phosphate rock and wood pulp. The commodities, composing the other groups, are as indicated by the title:

INDEX NUMBERS OF WHOLESALE PRICES IN SPECIFIED YEARS AND MONTHS, 1913, TO MARCH, 1922, BY GROUPS OF COMMODITIES
(1913—100.)

Year and month.	Farm products.	Food, etc.	Cloth and clothing.	Fuel and lighting.	Metals and metal products	Building materials	Chemicals and drugs	House furnish'g goods	Miscellaneous	All commodities
1913	100	100	100	100	100	100	100	100	100	100
Jan.	97	99	100	103	107	100	101	100	100	100
April	97	96	100	98	102	101	101	100	98	98
July	101	102	100	99	98	101	99	100	101	100
Oct.	103	102	100	100	99	98	100	100	100	101
1914	103	103	98	96	87	97	101	99	99	100
Jan.	101	102	98	99	92	98	100	99	99	100
April	103	95	99	98	91	99	100	99	101	98
July	104	104	99	95	85	97	99	99	97	100
Oct.	103	107	97	93	83	96	105	99	96	99
1915	105	104	100	93	97	94	114	99	99	101
Jan.	102	106	96	93	83	94	103	99	100	99
April	107	105	99	89	91	94	102	99	99	100
July	108	104	99	90	102	93	108	99	98	101
Oct.	105	103	103	96	100	93	124	99	99	101
1916	122	126	128	119	148	101	159	115	120	124
Jan.	108	113	110	105	126	99	150	105	107	110
April	114	117	119	108	147	101	172	108	110	117
July	118	121	126	108	145	99	156	121	120	119
Oct.	136	140	138	133	151	101	150	124	132	134
1917	189	176	181	175	208	124	198	144	155	176
Jan.	148	150	161	176	183	106	159	132	138	151
April	181	182	169	184	208	114	170	139	149	172
July	199	181	187	192	257	132	198	152	153	186
Oct	198	183	193	146	182	114	252	152	163	181
1918	220	189	239	163	181	151	221	196	193	196
Jan.	207	187	211	157	174	136	232	161	178	185
April	217	178	232	157	177	146	229	172	111	190
July	224	184	249	166	184	154	216	199	190	198
Oct.	224	201	257	167	187	158	218	226	196	204
1919	234	210	261	173	161	192	179	236	217	212
Jan.	222	207	234	170	172	161	191	218	212	203
April	235	211	217	167	152	162	178	217	216	203
July	246	216	282	171	158	186	171	245	221	218
Oct.	230	211	313	181	161	231	174	264	220	223
1920	218	236	302	238	186	308	210	366	236	243
Jan.	246	253	350	184	177	268	189	324	227	248
Feb.	237	244	356	187	189	300	197	329	227	249
March ..	239	246	356	192	192	324	205	329	230	253
April ...	246	270	353	213	195	341	212	321	238	265
May	244	287	347	235	193	341	215	329	246	272
June	243	279	335	246	190	337	218	362	247	269
July	236	268	317	252	191	333	217	362	243	262
Aug.	222	235	290	268	193	328	216	363	240	250
Sept. ...	210	222	273	284	192	318	222	371	239	242
Oct.	182	204	257	282	184	313	316	371	229	225
Nov.	165	195	234	258	170	274	207	369	220	207
Dec.	144	172	220	236	157	266	188	346	205	189
1921:										
Jan.	136	162	208	228	152	239	182	283	190	177
Feb.	129	150	198	218	146	222	178	277	180	167
March ..	125	150	192	207	139	208	171	275	167	162
April ...	115	141	186	199	138	203	168	274	154	154
May	117	133	181	194	138	202	166	262	151	151
June	113	132	180	187	132	202	166	250	150	148
July	115	134	179	184	125	200	163	235	149	148
Aug.	118	152	179	182	120	198	161	230	147	152
Sept.	122	146	187	178	120	193	162	223	146	152
Oct.	119	142	190	182	121	192	162	218	145	150
Nov.	114	142	186	186	119	197	162	218	145	149
Dec.	113	139	185	187	119	203	161	218	148	149
1922:										
Jan.	116	134	183	183	117	202	159	214	146	148
Feb.	126	138	183	183	115	202	159	213	150	151
Mar	128	138	182	183	114	202	159	213	153	152
Apr.	127	137	181	187	117	201*	160	211	152	152

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*Revised index numbers, including structural steel and other important building materials not included in the above figures, and with prices weighted by 1919 instead of 1909 census data, are as follows: April, 1921, 167; March, 1922, 155; April, 1922, 156.

Stucco Investigation.—The Bureau of Standards, in cooperation with interested manufacturers, is to carry out an investigation of stucco bases made of woven wire cloth and expanded metal lath. It is expected that 3 types of base now in general use will be applied over sheathed construction, and the performance of the various panels will be noted and analyzed.—U. S. Department of Commerce, Bureau of Standards, Technical News Bulletin, May 10, 1922.

The 705-Ft. Span Rondout Creek Suspension Bridge

By C. Y. WANG,

The Rondout Creek bridge at Kingston, N. Y., which will be opened to traffic this spring, is one of the largest bridges of its kind built in the country since 1909. The structure spans Roudout Creek about 2 miles above its mouth and forms a connecting link for one of the most important of the New York State highways.

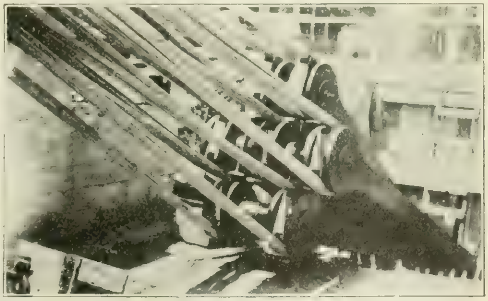
Rondout Creek Bridge of New York State Highway Department.

The bridge is of the suspension type, having a main span of 705 ft. and shore spans of 176.25 ft. each. Its total length from anchorage to anchorage is 1,145 ft. The maximum clear headway from mean high water level is 85 ft. The bridge provides a roadway of 22 ft. width with sidewalks on each side of the roadway of 7 ft. 6 in. Owing to the trusses of the bridge the actual width of the sidewalk is 4 ft. 4 in.

The steel towers, box form in section, are each 153 ft. above the concrete piers which have a difference in elevation of 20 ft. The piers are built on solid rock foundations.

The main cable, 9 in. in diameter, is composed of 1,974 high carbon steel wires of No. 6 R. G. in seven strands. The suspenders which hank the trusses to the cables consist of 1¼-in. galvanized steel ropes. Each main cable is anchored to the anchorage with 16 eye bars 9 in x 1 9/16 in., and these in turn are tied to the anchorage proper which is made of 24 Bethlehem H-sections 12 ft. long. The anchorage was sunk to a depth of about 60 ft. in the rock and the shaft then filled with concrete.

The stiffening trusses having bottom chords slightly curved is of the Warren type. Their average depth is about 11 ft. Each panel is 17 ft. 7½ in. long. Both top and bottom chord are composed of two 15 in. channels with double lacings. Two 10-in. channels form the diagonals of the trusses. Floor beams are spaced a panel length apart and are composed of 28-in. Bethlehem girders; 18-in. I-beams spaced 4 ft. 7 3/16 in. apart form the strings. The whole floor system is well braced with 12-in. plates. The total amount of steel used on the bridge, including the anchorages, trusses, cable work, and the floor system, weighs about 3,000 tons.

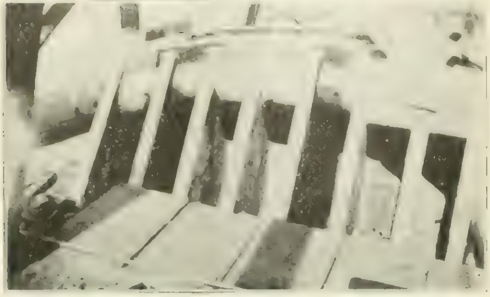


Northeast Anchorage Before Concreting.

The roadway, which is 9 in. thick at crown, is composed of reinforced concrete of 1:1½:3 mixture. The sidewalks, 4 in. in thickness, are made of 1:2:4 concrete.

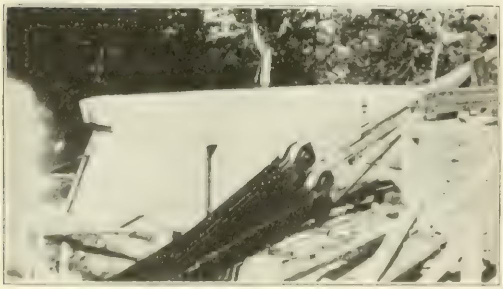
In building the roadway, sidewalks and approaches 7,000 bbls. of Pennsylvania portland cement and 80 tons of Havemeyer reinforcing bars were used. The roadway was laid in [illegible] working days and the sidewalks laid in 21 working days.

Ten guy derricks of 25-ton capacity, each resting on timber towers about [illegible] ft. in height, were erected along the side of the steel towers during construction. Their location



One of the Saddles.

Cable Band and Suspender Socket.



Southwest Chamber Under Construction.

gave them ability to answer any need for erection. Traveling derricks were used in the first stage of main span steel erection, but owing to their comparative heaviness they finally replaced by [illegible] stiff leg derricks. They were hauled to the towers and [illegible] were rigged from each main cable to the [illegible] for the [illegible] of the steel erection. The main trusses were erected from both towers towards the center. A special traveling scaffold was installed to operate on the wind chords, forming part of the sidewalk frames, after the main trusses met together. By means of this scaffold the erection and taking down of timber forms for the roadway, the riveting of the main trusses and the field painting, were successfully accomplished without interruption.

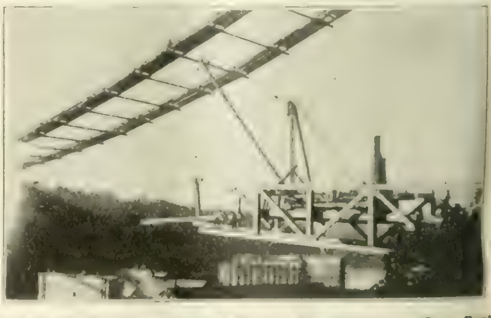
Operation of Cable Stringing.

Efficient supervision and organization was well manifested by the absence of any single accident during the work.

The actual construction was started in September, 1920, and an average force of 60 men was actively employed on the work for a period of about one year. The bridge will be opened to traffic this spring.

The bridge is designed to carry a continuous load of 10-ton trucks. It has a grade of about 5 per cent on the Kingston side and ½ per cent on the Port Ewen side up towards its center. The total estimated cost of the bridge is about $700,000.

Terry-Tench Co., Inc., of New York City, were the contractors, with H. D. Robinson as their consulting engineer. The New York State Highway Commission, under whose direction the work was done, was represented by W. E. Joyce as resident engineer in charge of the project. D. E. Moran and W. H. Yates were responsible for the designs of the substructure and the superstructure respectively.



One of the Traveling Derricks Picking Up Members in First Part of Main Span Erection.

Canada's Greatest Concrete Bridge

234 Foot Main Span and Ten Approach Spans — True Spandrel Arches — No Beam and Slab Floor System — Beauty of Structure Given Special Consideration*

By FRANK BARBER,
Consulting Engineer of Frank Barber & Associates, Ltd.,
Toronto.

The high level bridge over the Otonabee River, Peterboro, recently completed, represents one of the most important pieces of construction work carried out in Canada in recent years. Work was commenced in August, 1919, and completed just two years later in August, 1921. The structure, generally known as the Hunter St. Bridge, replaces a steel bridge of two spans, of much lower elevation.

The new bridge is of concrete and is made up of ten approach arches, five on each side of the river, with one main river span which is 234 ft. in length the largest single concrete arch span in Canada. It was built as the result of an agreement between the Quaker Oats Company, who own the land on either side of the river at this point, and the city of Peterborough, following the disastrous fire at the above company's plant in 1917. The bridge contains 15,000 cu. yd. of concrete and 180 tons of steel. There are 1,172 lin. ft. of concrete in the eleven arches and approach walls, four of the arches being 30 ft. in length, six 60 ft. and the main river arch 234 ft. with a total of 7,000 cu. yd. of earth fill on both sides of the river. The floor of the bridge is 52 ft. above low water level. The roadway is 35 ft. wide between curbs and carries a single track electric railway line.

Approach Spans.—The sidewalks on the approach spans project out over the spandrel walls $2\frac{1}{2}$ ft., by the cantilever construction on the top of these walls, but aside from this feature the arches are of the ordinary earth filled type. The piers under the approach spans are solid from side to side of the bridge, at the height of the skewbacks, but below this each pier is pierced by a transverse arch, dividing the pier into two parts, with 12 ft. spaces. In order to provide uniform bearing upon the foundations, of four tons to the square foot the maximum allowed by the chief engineer of the Ontario Railway Board—spread footings were used for the piers. The structure, at the west abutment, rests upon bed rock, the eastern abutment being on a very hard hard-pan.

The necessary clearance for an overhead crossing of the steam railway sidings at the west approach was the factor that determined the elevation of the bridge floor, it being impossible to alter the elevations of the railway tracks as they must conform to the loading floors of the Quaker Oats Company's plant immediately on the north side of the bridge. This condition resulted in the elevation of the bridge floor being 6 ft. higher than the general elevation of the city streets, which necessitated a grade up to the bridge on either side.

The Problem of Crossing Sidings.—One of the first problems to be solved in the designing of the bridge was, therefore, to devise a type of structure that would leave the floor at as low a level as possible, for traffic accommodation, while fulfilling the requirements of the Dominion Railway Board as to clearances above the railway siding. The problem of bridging railway sidings in pairs would be comparatively easy, generally speaking, as railway sidings are ordinarily 13 or 14 ft. apart, center to center, but the sidings in question were something over 20 ft. apart on centers and would cross the bridge approach on curves and cut a sharp angle. The location of the sidings was altered as far as possible to suit the necessities of the bridge, the sidings being made more nearly to approach a right angle crossing, which layout was approved by the Railway Board. After extensive investigation to secure a type of construction with the least difference in elevation between the floor of the bridge and the under side of it for the space required by the Railway Board, according to their diagram of clearances, flat arch construction was decided to be a better solution of this particular problem, than steel girders or concrete beams.

Approach Arches.—The soffits of these flat approach arches are semi-ellipse, the curvature being found in the following manner: The dead line of resultant pressure was made to fit exactly the neutral axis of the arch and the required depths of the arches from crown to skewback was found to be such that the soffit of the arch, except quite near the skewback, was practically the arc of an ellipse. A true semi-ellipse resulted for the curve of the soffit from thickening the arches quite close to the skewback. Except in the case of flat arches, the designer of this bridge has found that a semi-ellipse for the soffit is not possible for the most economical design of curvature.

Needless to say, the dead load horizontal thrusts of all the approach arches are exactly the same, so that there is no turning moment on the piers from dead loads. The horizontal thrust of the 30 ft. arch, by making the smaller arches sufficiently flat, is made equal to that of the 60 ft. arches. The elevations of the 30 ft. arches were kept sufficiently low to allow the dead load line of resultant pressure on the smaller arch to meet that from the larger arch on the vertical center line of the pier.

The Peterborough Bridge.

The Design of Curvature.—Although the curvature of the neutral axis may be made to fit the line of resultant pressure by a "Trial and Error" graphic method, the direct design of curvature is possible by a much simpler analytical method, using a book of tables of hyperbolic functions, which method has been used by the author in the design of all his arches for some years. There can be no bending moments in such a design, in any part of the arch ring, from dead loads, and, consequently, dead load stresses are uniform compression on any section. Tensile stresses, however, result from live loads and temperature. As sometimes happens, the maximum tensile stresses are not as great as the dead load compression stresses in which case there will never be tension on any part of the arch, and therefore reinforcing steel is not necessary. In very large arches where the dead loads are great compared with live loads, this is generally the case. In this structure, the river arch ring is plain concrete without any reinforcing. It may be interesting to note that most of the designers of the great arches of the world have found similar conditions. In 1911, the designer of this bridge made a list of all the concrete arches over 175 ft. in span, thirteen in all, of which only four were reinforced.

Centering of the Main Arch.

The river arch, as is the custom in all great arches, was poured in voussoirs of about 14 ft., leaving key spaces of about 4 ft. between them, which were concreted after the voussoirs had set. Two purposes were accomplished by this method: it prevented internal stresses due (1) to the settling of the arch ring upon the centering and, (2) from shrinkage of the concrete in setting, which developments had practically taken place before the key spaces were concreted. The arch ring contains over 2,000 cu. yd., without the superstructure, and consequently weighs upwards of 4,000 tons.

Advantages of Temporary Hinges for Arch Rings.—To ensure the neutral axis following the line of pressure, as required by theory, the arch ring was built with temporary hinges near the skewbacks and at the crown, which expedient of temporary hinges has been used by many designers of large arches. After the superstructure was completed and the full dead weights applied the hinges were concreted over and fixed against further movement, at which time the line of pressure must pass through the middle of the section at the three hinges and consequently follow it very closely at all other points. There is a further possible advantage in building a large concrete arch with temporary hinges. It is necessary, in order that the temperature stresses should have the minimum effect, that the possible rise of temperature in the arch ring above the average temperature should be equal to the fall of temperature below it. A thermometer was buried in this arch in the concrete near one skewback, and when the temperature of the ring had fallen to 42 deg. F., the average local temperature, the temporary hinges were concreted over, fixing them against further movement. As is often the case, when an arch is closed in a warm season, it might be noted that the natural heat of the season and the unnatural heat generated from the setting of the cement, cause the arch ring to attain a greater temperature than is to be expected at a later time. Thus, the maximum temperature stresses, which would in this case occur in the coldest weather, would be more than double what they would have been had the ring been closed when its temperature was midway between the high and low temperature of the year. This principle of minimizing the temperature stresses had been taken advantage of for the first time, it is believed, in this structure.

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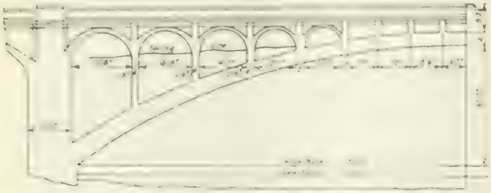
*From: The Contract Record and Engineering Review, Toronto, Canada.


Half Elevation of Main Span Showing Effect of Varying the Length of Spandrel Arches

Spandrel Arches with Fill Above.—Unlike most open spandrel arches built up to the present time, which have been of beam and slab construction in the floor system this river arch is designed with true spandrel arches, being barrel arches, with a cinder fill above them. Comparing the merits of the two systems, it will be found that beam and slab construction results in slightly less concrete and less dead weight imposed on the large ring, but, on the other hand, this type of construction requires much more steel than arches and involves greater labor and false work. Although previous to the beginning of the war the saving of concrete material was worth more than the saving of labor and steel in arch construction, conditions, at the time this particular arch was designed, had changed, concrete materials having not advanced in price to the same extent as labor and steel. Two further examples of similar construction were the recently completed bridges at Lyons, France, and Pont Sidi Rached, Algeria.

Where the floor system is of beam and slab construction, the overhang of the sidewalk is generally greater, as the cantilevers upon which the sidewalk rests are simply the ends of the floor beams. In spandrel arch construction, however, there are no floor beams, of course, and sidewalks cannot be made to overhang to the same extent.

In spandrel arch construction, an advantage worth noting is that the spandrel arches may be made successively smaller from the skewbacks to the crown, this foreshortening of the spandrel arches towards the crown resulting in saving of material, the arches becoming smaller as the spandrel piers become shorter, while it must also be admitted that the appearance of the spandrel arches is greatly improved over the more ordinary case where the spandrel spans are uniform. Economy, however, requires that the size and reinforcing of the units in beam and slab construction be uniform. The unequal spans were chosen in this case primarily on account of their appearance, the feature of economy becoming apparent later. Mr. Claude Bragdon, consulting architect on the bridge, is responsible for this feature in the design, which is believed to be original.

Cost of Structure.—It was originally estimated by the civic authorities in 1917 that this structure would cost $225,000, but when tenders were called in the fall of 1918, bids received ran from $334,000 to $381,000, which necessitated the submission of a by-law authorizing the extra expenditure. No difficulty was experienced in having this by-law ratified, however, and tenders were called again the spring of 1919, three bids being submitted on the lump sum basis, ranging from $260,000 to $263,000, and eight contractors, who figured on the cost plus basis, estimated the cost from $240,000 to $285,000. Messrs. Russell Townsend & Co., Ltd., were finally awarded the contract at cost plus a fee of $29,500, this amount to cover plant rental, etc. The total cost, however, was slightly over $500,000, materials advancing rapidly in price at this time. A fairly close parallel case to this was that of the Fairmont bridge, in West Virginia. This bridge was begun a little before the Peterborough bridge, and completed somewhat later than it. The quantities were somewhat greater, and the contract was let in the same way, cost plus $40,000. The estimated cost was $338,000, and the final cost somewhat over $800,000.

The bridge was designed by the writer, and Claude Bragdon was the architect, the construction being supervised by the writer. There was a staff of three resident engineers on the bridge, Mr. Fred [illegible] being chief. Mr. R. H. Parsons is city engineer of Peterborough.

Lightning Rods and Fire Losses

The Eleventh Annual Report of the State Fire Marshal of Iowa for the year 1921 includes the following with regard to fire losses where lightning and lightning rod protection is involved:

"The use of the lightning rod is almost an absolute protection against loss by lightning. I have gone into this matter very thoroughly and the records will show that in 1919 there were 227 lightning fires of which 131 were farm barns, only 7 of which were rodded. The loss on these farm barns was $265,945. Of the balance of these lightning fires only two were rodded.

"In 1920 there were 157 lightning losses. In 143 cases there were no rods and the loss was $362,390; lightning running in on wires, 5 with a loss of $1,119; 9 losses with rods, causing a loss of $26,209.

"In 1921 there were 158 lightning losses, 142 without rods, causing a loss of $284,203; lightning running in on wires, 6, loss, $3,963; 10 with rods, loss, $32,775; and there is evidence tending to show that where the rodded buildings were struck, the rods were either defective or not properly installed."

Cost of a Wood Block Factory Floor

The following data on a creosoted wood block floor were obtained from the Republic Creosoting Co. of Indianapolis, who furnished the material for the job. The base used was an old plank floor. It was covered with tar paper, mopped down, and the blocks laid upon this surface. The blocks were 2½ in. thick, 4 in. wide, and in random lengths from 6 to 8 in. Pitch for filler and bed totaled 16 lb. per sq. yd. A total of 4,650 sq. yd. of floor was laid. On account of freight charges the cost of the blocks will vary somewhat with location, but the other items are quite stable.

The total cost was $2.16½ per sq. yd., made up as follows:

Blocks	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
Labor	[illegible]
Tar paper, mopped down with tar	[illegible]
	$2.16½

Student Chapter of Industrial Engineers. A chapter of the Society of Industrial Engineers was recently organized among students at Carnegie Institute of Technology, Pittsburgh, to be known as the Carnegie Industrial Engineers Society. This is the third chapter to be organized in this country.

Cost of Operating Municipal Testing Laboratory.—For the operation of its testing laboratory during the year ending April 10, 1923, the City of St. Louis has appropriated $24,120, of which $22,400 is for salaries and wages.

A Bad Time to Bid Low

By M. V. AYRES,
Statistician Associated General Contractors of America.

Rumors come to us that contractors generally are exhibiting a tendency to bid lower on all kinds of construction work than they were willing to do a few months ago. Does the present outlook justify lower prices for construction work?

The general level of prices has been going up, now, for the past two or three months. All authorities agree that the business depression has reached the bottom, and we are now on the upgrade. There is practically no exception to the rule that prices generally increase somewhat during the period following a depression, when business is recovering. We believe that this is now occurring and will continue probably for at least six months to come. The long time tendency of prices will probably be downward for many years, but for the present, and for some time, they are going up. It is not safe to cut bids on the assumption that prices of materials will be lowered.

Wages in many lines have been reduced rather severely during the past few months. Doubtless, many employers feel that they must come down still more. Unquestionably, in some places and in some industries, where wages are still at the peak, some reduction will be made, but a time of improving business is not a time when wages generally can be reduced. Immigration has been restricted in such fashion as to greatly reduce what has in past years been the principal source of recruits for the ranks of common labor. An increase in business prosperity will raise the cost of living and increase the demand for labor. We do not feel that bids can safely be made at lower levels on the assumption that wages are going to be reduced.

Much has been heard to the effect that freight rates must come down, if prosperity is to return. The importance of this factor has been greatly overstressed. Business is improving and freight rates are staying up. Some reductions, it is true, have been made and some more may occur, but the railroads have made only a beginning toward a recovery from a desperate financial plight in which they have been, and they will not willingly submit to any very drastic, or very extensive reduction in their charges. We do not believe that prospective reductions in fregiht rates are any justification for bidding low on construction projects.

It is perhaps quite as important that a contractor should get his materials when he wants them as that he should get them at the right price. At present, stocks of most things are large, and production capacity is not being used to the full. These conditions are favorable, but how long they will stay so is problematical. Demand is increasing. If the coal strike continues all summer, many industries will not be able to produce up to their normal capacity or perhaps even at their present rates. We do not feel that contracts can be taken with any assurance of prompt deliveries of large quantities of material several months from now.

If business picks up as we hope it will there is going to be a car shortage before the summer is over. The railroads are under-equipped both in cars and locomotives for handling the normal business of the country. Even if their equipment were all in good condition a car shortage would be the hardly avoidable accompaniment of the next period of even ordinary prosperity. But it is not all in good condition. There are nearly 200,000 more cars unfit for service than there ought to be under normal conditions of maintenance. If conditions were such that a car shortage existed of precisely this amount, 200,000 cars, it would be a very serious shortage. We do not think that low prices for construction work are justified, if they are based upon the assumption that freight cars will always be available when they are wanted.

Anyone contemplating making a low bid on construction work should not do it on the assumption that materials are going to be cheaper, that wages will be lower, that freight rates will be reduced, that deliveries will be prompt, that freight service will be adequate and that all things will be harmonious, for not one of these assumptions is likely to be true.

Brick Association Moves.—The Common Brick Manufacturers' Association of America will occupy new quarters at 2121 Discount building, Cleveland, Ohio after May 19.—Ralph P. Stoddard, Secretary-Manager.

Modified Cost Plus Fixed Fee Contract

Special Features and Methods of Handling Work, Outlined in Paper Before Boston Society of Civil Engineers

By THOMAS C. ATWOOD,
Of T. C. Atwood Organization, Chapel Hill, N. C.

The trustees of the University of North Carolina were suddenly confronted with the problem of spending some $1,500,000 for buildings and other improvements. I say suddenly, because within a few days near the close of the last regular session, the legislature appropriated this sum and also abolished the state building commission which had up to that time handled the construction work for all state institutions and threw each institution upon its own resources. The trustees appointed an unusually able building committee which desired to proceed at once with the work as the need of increased facilities was great.

The program which I suggested to them seemed to make the correct analysis of the situation and they engaged me to carry it out. This program was, in brief, first to organize a force of architects and engineers to design the work on the ground and supervise its construction and second to let the entire work to a capable contracting firm on some form of cost plus contract and to get them started just as soon as the first plans could be prepared.

Why the particular form of contract was selected.—The form of contract selected was a modification of the "cost plus fixed fee" and was selected for the following reasons:

It was desired to start construction at once without waiting for preparation of plans and specifications and letting of lump sum contracts.

The construction was to be in a small town of less than 1,500 normal population with little available labor, and to have two or more contractors fighting each other for labor would be unfortunate.

There was no housing available for the construction forces, and as this must be constructed it could be done most economically under direct ownership of the university and remain for future work.

The introduction of a large construction force into a small country town was fraught with dangers which could best be controlled under such a form of contract.

It was desired to control the speed of progress in order to secure the buildings when most desired. The most recent building constructed at the university had been delayed for many months because it was let on a lump sum basis in a falling market and it was to the advantage of the contractor to delay it.

On the other hand there was a very real objection to what was termed the "wasteful cost-plus war time contracts" and the problem was to produce a form of contract which would meet the necessities of the case and yet avoid the objection stated above.

The form of contract.—The form adopted as given herewith:

AGREEMENT.

This Agreement, made this 17th day of June, 1921, by and between the Trustees of Building Committee of the University of North Carolina, of Chapel Hill, N. C. (hereinafter called the Owner) and T. C. Thompson & Brothers of Charlotte, N. C. (hereinafter called the Contractor).

Witnesseth: That the parties agree as follows:

ARTICLE 1.

Contractor to Furnish.

The contractor shall furnish a skilled organization and shall carry on the work of construction of college classroom buildings, dormitories, dwellings for members of the faculty and such others as may be designated and the overhauling, changing or repairing of any buildings, and any other structures which the owner may require, all to be located at Chapel Hill, N. C., and shall provide sufficient supervision from his main office to insure efficient and economical handling of the work.

ARTICLE 2.

Plans and Supervision.

The Owner has appointed T. C. Atwood, Engineer, as his Executive Agent on all matters pertaining to this contract and all matters involving expenditures are to be approved by him or members of his organization acting within the scope of the authority [illegible] to them before the orders are [illegible] expenditures made.

The various structures are to be built, added to or repaired in accordance with plans and specifications prepared by the [illegible] and all work is to be done under the supervision of that organization.

ARTICLE 3

Financial.

The Owner will advance from time to time all funds necessary to carry on the work and the Contractor shall render strict account of all expenditures and each month a monthly report showing in balanced form [illegible] statement [illegible] expenditures.

All invoices and vouchers for labor and material [illegible] by the Contractor must be passed by and be paid for by the Owner.

The Owner is to receive the benefit of all discounts, drawbacks, rebates, insurance dividends, unpaid wages and all similar items tending to reduce the cost of the work.

ARTICLE 4

Guaranteed Estimates.

As soon as the plans and specifications for any structure are sufficiently completed the Contractor shall prepare and submit to the Committee an estimate of the total anticipated cost of the structure and shall guarantee that the total cost of the structure insofar as shown by the plans and specifications on which the estimate is based, shall not exceed the estimate given. The estimate shall be submitted to the Engineer of the Owner for approval. In case of disagreement a third party shall be agreed upon whose decision shall be final and binding on both parties. The expense of employing this third party shall be borne equally by the Contractor and the Committee. Should the cost exceed the estimate approved or finally agreed upon, such excess cost of the structure shall be borne by the Contractor up to the amount of his fee upon this structure.

ARTICLE 5

Liens.

The Contractor shall indemnify and save harmless the Owner from materials and mechanics' liens arising out of the work to be performed under this contract.

ARTICLE 6

Bond.

The Contractor shall furnish a fidelity bond in the amount of twenty-five thousand dollars ($25,000) insuring the faithful performance of the various provisions of this contract and this bond shall be approved by the Owner. The premium on the bond will be paid by the Owner.

ARTICLE 7

Traveling Expense.

Whenever necessary in the judgment of the Owner traveling expense to the job one way shall be allowed to men in the job organization, to be paid after satisfactory service. Return traveling expense will not be allowed.

ARTICLE 8.

Fee.

For his services the contractor shall receive the lump sum fee of ______ based on the completed value of work of $1,100,000 or a proportionate fee should the total value of completed work be less than this sum. If on the other hand, the value of completed work be greater than $1,100,000 an additional fee of ______ shall be paid for each $100,000 additional value, no fee being paid for smaller increments than $100,000 to the main sum. Fees shall be payable monthly on the basis of the value of work done during the preceding month compared to the total. Ten per cent of the fee may be retained by the Owner until the satisfactory completion of the job.

ARTICLE 9

Fee Includes.

The fee paid to the Contractor shall include his compensation and all expenses to which he is subjected except the cost of the job organization. The fee to the Contractor will include his home office expenses, including salaries, traveling expense, telephone and telegraph charges. Any special service requested of the Contractor's home office by the Owner shall be paid for as an extra expense. The general service to be furnished by the Contractor's main office [illegible] include the following: All work necessary to establish [illegible] a proper organization, the setting up of [illegible] systems, [illegible] and cost keeping, the services of his employment and personnel department in supplying the job with [illegible] the services of the purchasing department in the purchase of materials whenever this is requested by the Owner, the purchase of [illegible] to be subject to the approval of the Owner, [illegible] at least [illegible] the progress of the job [illegible] the job [illegible].

ARTICLE 10

Termination of Employment.

The employment of the Contractor may be terminated at any time by the Owner [illegible] after written notice to this effect [illegible] days. In any case the Contractor shall use his best efforts to turn over to the Owner all property and records in the best possible state.

The Contractor shall be entitled to receive such proportion of the total fee as the sum of the expenditures at the date of termination plus bills due and payable at that date bear to the total estimated expenditure on his portion of the work, subject to the provisions of Article 8.

ARTICLE 11

Access to Records.

The Contractor shall permit the Owner free access at all times to all records, correspondence, [illegible] and similar papers relating to the work and all records shall remain the property of the Owner.

ARTICLE 12

Insurance.

The Owner will secure insurance covering loss by fire and tornado on materials and uncompleted structures and against liability for injuries to the persons and property of employees and the public.

ARTICLE 13

Sub-Contracts.

It is understood that the object of this contract is to reduce the number of sub-contracts to a minimum. The placing of sub-contracts is to be approved by the Owner. The right is reserved by the Owner to place any sub-contracts independently of the Contractor.

In Witness Whereof

The said parties to these presents have hereunto set their hands and seals the day and year first above written.

(Signatures)

Special Features of the Form of Contract.—You will notice several special points regarding this contract. First, it is a "cost plus fixed fee" contract, based on a certain fixed expenditure with fee reduced proportionately for a lesser expenditure. Second: Provision is made for increasing the expenditure by securing a subsidiary fixed fee for each additional $100,000 of added expenditure. Thus the state is protected against payment of the full fee if unforeseen conditions require the amount expended to be materially reduced while the contractor is protected against being required to make largely increased expenditures without compensation. The contractor, it is true, may be required to expend $99,000 without added fee, but this is only an increase of 9 per cent in the principal sum and is not unreasonable. To allow an added fee for smaller sums would be practically a return to the straight "cost plus a percentage" contract which it was expressly desired to avoid. Third: It is provided that before beginning work on each structure an estimate of its cost shall be prepared and agreed upon between the contractor and the engineer of the committee with provision for arbitration in case of disagreement, and the contractor shall guarantee this estimate to the full amount of his fee on each structure. This, you will observe, gives the state the benefit of a reasonably close approximation of cost in advance on each structure and also provides the necessary incentive for economical work on the part of the contractor.

It is true that this requires a considerable degree of mutual confidence between the contractor and engineer, but this has come to be recognized more and more of late years as an extremely desirable feature of construction work. In the present case half of the total expenditure is now covered by these guaranteed estimates and in no case has there been any thought of the necessity of resorting to arbitration, all estimates having been mutually agreed upon with little difficulty and the respect of each side for the other has been constantly strengthened.

Fourth: A bond is required. This was not originally contemplated, but when I went over the contract with the attorney general, he thought it best to call for a bond principally because it is the custom for all public contracts to require one, this of course being due to the fact that the majority of such contracts are of the lump sum variety. In this case the bond instead of being the ordinary construction bond was restricted to a "fidelity" bond in the sum of $25,000, merely to provide for proper handling of business, the necessary money for the carrying on of this work being advanced to the contractor by the university. The unusual nature of this bond is shown by the fact that the bonding company had no appropriate blank and it was necessary to take a "personal" bond blank and alter it to cover the case.

Fifth: It is clearly stated just what we would do in the way of allowance for traveling expense, this being allowed only to men in the job organization and only one way, and this only in case we admitted the necessity. So far there have been but few cases in which travel expense has been allowed. The railroad fares of labor it was necessary to import has been advanced as usual, but later deducted from the wages due and we have had no difficulty in getting labor. This gives you an idea of how nearly we are getting back to normal.

Sixth: The contract clearly states that the fee paid to the contractor includes not only his profit, but also all expense to which he is subjected except the cost of the job organization. It covers his home office expense, including salaries, traveling expense, telephone and telegraph charges and specifies in considerable detail the work and traveling which is expected of the home office force.

I have handled a great deal of "cost-plus" work in the last few years, and have found that there are generally mote petty annoyances in the home office expense accounts and greater difficulty in checking them up than in any other one thing on the job, and determined to eliminate this cause of friction. By specifying clearly the minimum number of trips to be made by members of the home office organization, this item could be readily approximated for putting in the bid and the question as to whether too many trips are being made does not arise.

The telephone and telegraph expense is small, but it is slightly disconcerting to find some subordinate in the home office sending numerous long telegrams or submitting heavy long distance telephone charges in regard to materials which will not be purchased for weeks or months and on which the mail would be sufficiently quick and as a rule more satisfactory.

Seventh: Termination of Employment. Provision is made for terminating the employment of the contractor at any time on ten days' notice. Nothing is said about termination for cause and this omission was made after due thought. With the clause as it reads the contractor can be discharged at any time without the necessity of giving reasons or making troublesome explanations which may form the basis of financial claims or even of law suits. The terms of settlement are made a part of the contract so as to avoid claims for anticipated profits on the uncompleted part of the work. It is true this method of termination puts a powerful weapon in the hands of the owner, but the contractor knew in advance the men with whom he had to deal, and besides the owner will always be reluctant to make a change in contractors as the trouble and expense of such a move is sure to be great and to be undertaken only as a last resort.

In all 28 bids were received, two of which were irregular, but the remainder bid on the contract exactly as written and without a protest. The list of bidders included some of the largest and best known firms in the East, and all seemed not only willing but anxious to undertake the work on these terms. The price bid varied from $40,000 to $80,000, or a fee of about 4 to 8 per cent.

The methods of handling this work have been thoroughly worked out and are given below:

Purchasing.—The contractor is required to secure the authorization of the engineer before making any purchase amounting to $100 or over. Smaller purchases he is allowed to make without prior authority but must submit these bills with the others, so no purchase escapes scrutiny. A special form of authorization is used, which I designed some years ago on similar work and have since used exclusively. It provides spaces for the following essential points:

1. Description of article to be purchased.
2. Bids received per unit and total.
3. Delivery offered.
4. Point of delivery, that is, whether f. o. b. job or where.
5. Recommendation of contractor as to which bid is most advantageous and why.
6. Signature.
7. Approval of engineer.

This you will notice places on file all the needed information on a single sheet in a form easily referred to.

The question frequently arises, why was a certain article purchased from the firm and in the manner it was. This is easily looked up in the file of purchase authorizations without recourse to the contractor's file of bids and again comparing them.

It is sometimes the case that the engineer disagrees with the contractor by reason of more complete knowledge of the necessities of the case and decides to order from a different firm, perhaps at an increased price. If so, the record is clear and complete and the responsibility properly fixed.

Accounting.—The contractor is required to hand in each week a balanced financial statement, showing all expenditures made to date, backed up by vouchers.

This shows the state of the finances, but of course does not show the commitments nor the way in which the job is progressing as compared with the estimated cost. The latter is shown by periodical statements which show the cost to date, plus the estimated cost to complete. Daily cost sheets made by the cost clerk are sent to the engineer's office by noon of each day, showing the unit labor cost on the principal items for the previous day, thus giving an opportunity to continually compare actual with estimated labor cost and take remedial steps before it is too late.

Employment of Labor.—Standard rates for the different classes of labor were set at the outset and have been adhered to so far with little deviation. Common labor is paid 20 ct. per hour, carpenters 50 ct. to 60 ct., and brick masons 75 ct. Overtime is paid for at the same rate as regular time. The labor camp is run on a contract basis, the man in charge of the camp being paid $5.00 per week for each colored man boarded and $6.00 per week for each white man. This amount is deducted from the wages. Colored labor is housed in a separate camp from white. The colored labor is of the regular shiftless, slow, easy-going kind usually found in the South, happy and care-free, ready to work hard if the proper singing leader is provided, but preferring to loaf rather than to work any day. A sharp lookout has to be kept for labor agents from other towns trying to get our men to leave. There are laws in North Carolina making this a hazardous occupation and more than once I have called upon the mayor to see that a certain party ceased his flattering but annoying attentions. The old way used to be to waylay the offender and beat him up, but this method, simple and direct though it be, seems to be falling into disfavor.

Inspection.—The work is carefully supervised by a resident civil engineer and one or two inspectors. There is, of course, less need of detailed inspection than on a lump sum contract, but I have never seen the construction job of any kind where an intelligent inspector was out of place and unnecessary, and most good contractors feel the same way.

Working Out of Contract.—Our paths have not always been strewn with roses, but on the whole everything has worked out admirably. There has been no difficulty in agreeing upon guaranteed estimates and in the case of the jobs which have been finished, the records show costs to run very closely with the estimates. The only exception is in the carpenter labor which has run high, showing that the efficiency of this class of labor has not returned to normal. Recent figures on the dormitories show that they are running close to the estimated costs with a possible saving of about 3 per cent.

So far our experiment seems to be working satisfactorily and all hands are working faithfully together to make this continue to the end.

Gas-Tar Protects Concrete Against Alkaline Waters

In its search for a means of protecting Portland cement concrete against the action of alkaline waters, the Bureau of Public Roads, United States Department of Agriculture, announces promising results from treatment with a very fluid water-gas tar, such as may be obtained as a by-product from many artificial gas plants. So successful have the tests been that further investigations of the alkali-resisting properties of tar-treated concrete and mortar are under way and the protective effect of water gas tar on mass concrete structures is being studied.

The treatment consists of simply immersing the concrete in the liquid, which is soaked up, even by a dense concrete. Cement drain tile treated in this way and stored from six to eight months in a strong alkali solution have shown no indications of disintegration, and samples tested for tensile strength were as strong as those stored in pure water. On the other hand, untreated samples showed both disintegration and a loss of strength.

In certain parts of the country where alkali salts exist concrete drain tile and concrete structures have been attacked. In many such places concrete is a very desirable material on account of the accessibility of the materials that go into it. The bureau's investigations aim to devise means of using concrete with assurance.—U. S. Department of Agriculture Press Service.

The Importance to the Contractor of Better Cooperation Between Contractors and Engineers*

By C. H. McALLISTER

[illegible]

It is the aim of the responsible contractor to do reliable, skilful and honest construction, satisfactory to the owner and his representative, the engineer or architect, as well as profitable to the contractor himself.

The relationship between the owner and the contractor should be one of mutual responsibility and of close cooperation, by which the interests of both are best to be served; and by the promotion of this cooperation the responsible contractor through the work of the A. G. C. seeks to avoid, as far as possible, differences of [illegible], opportunities for misunderstandings, and very often expensive law suits. All of these not only breed suspicion of the contractor in the mind of the engineer, but result in the writing of specifications, so full of one-sided clauses, restrictive beyond reason, that the contractor is encouraged to gamble if he bids at all, adding an unreasonable amount for contingencies which he fears may arise in carrying out a contract in which the engineer has reserved unto himself arbitrary authority and has decided in advance questions concerning responsibility, which very often arise through the design of the structure or the written provisions for its construction.

Restrictive Clauses in Specifications.—The Associated General Contractors of America know that the irresponsible contractor is largely to blame for such restrictive clauses in specifications and that this is particularly true of public works contracts. There is in this Association a determination to eliminate conditions which encourage irresponsibility, embracing as it does unfair practices, defective work, deliberate violation of agreements, etc., etc. This Association proposes to set up a plan for the promotion between owner and contractor of that relationship of mutual responsibility which will insure the elimination of unfairness and establish that cooperation which will ultimately result in a saving of time, money and temper to both parties of the contract.

It is this which the Associated General Contractors of America has in mind in presenting this matter to you today for discussion, requesting of the engineer his cooperation in this important undertaking, believing that the engineer is also vitally interested in the elevation of the construction industry.

The first step is the standardization as far as possible, of specifications, particularly of those general clauses which either mean so much or so little.

Plans should be clearly drawn and should be complete before they are given out. The opportunity for disputes because of additions, eliminations or deductions should be reduced to a minimum.

Engineer Should Back Borings.—Borings or test pit excavations should be made and the results published by the engineer. It is the general practice to make borings, exhibit them, and then disclaim responsibility. There is more trouble in connection with foundation work due to lack of reliable information as to soil conditions than there is with any other class of general construction; and, while we realize that the present hit or miss method of making borings is very unsatisfactory and misleading, we believe that borings can be made or test pits dug which will fairly represent subsurface conditions. This information will in itself tend to eliminate the opportunity to gamble and to prevent [illegible] of [illegible], saving many times over the cost of the preliminary investigation besides giving the engineer himself reliable information from which to accurately design the [illegible] substructure and save [illegible] revisions to his plans as originally submitted for competitive bids.

Of course, it may be said that the bidder is notified to carefully examine the site of the work and satisfy himself by borings or test pits as to the conditions existing. The time allowed for the preparation of bids is usually so short [illegible] and even should the responsible contractor wish to make these borings, it is likely that he would need official permission to make them on public property, particularly on streets and highways. We hold that the furnishing of this information should be as much a part of the owner's duty, as it is the furnishing of the plans and specifications governing the construction of the work.

The Gamble in Contracting.—In examining plans and specifications before the submission of a bid, the responsible contractor generally designs a plant layout for the handling of the work. Of necessity he must use the approximate quantities which are submitted to him as a part of the specifications for the design of a plant layout. Consider how he must necessarily gamble on this large item alone, if he is furnished with quantities which are not approximate. Of course, we realize that a statement of quantities must be approximate, but they should vary only by a small percentage. Many instances could be cited to show the unreasonable expense to which contractors have been placed through the failure on the part of the owner and his representative, the engineer, to give the bidders this information at the time of requesting the bids. When the engineer realizes that the bidder's estimate depends so largely upon the correctness of the quantities given, and that these are not only for the purpose of a comparison of bids but are so essential to the responsible contractor in preparing his bid, we are sure he will then consider it of great importance to himself, as well as to the bidder, to have these quantities as nearly correct as it is possible to get them. Specifications, of course, contain clauses advising the bidder to satisfy himself as to these approximate quantities, some specifications even placing upon the contractor the obligation of checking the plans and specifications and imposing upon him the duty of notifying the engineer of errors of omission or commission. It is unreasonable to expect the contractor with his engineering working force to do in a few weeks what it has taken the owner's engineering force several months to do. If a responsible contractor took cognizance of all such clauses, it would mean the employment by him of an engineering office force, the cost of which, added to his overhead, would mean his inability to compete against the irresponsible contractor for any work at all.

Standardize Specification Clauses.—The cooperation of the engineering fraternity is earnestly requested in the standaridzation of general clauses of specifications. It is our desire to eliminate clauses which are restrictive, indefinite, and which would probably tend to promote serious misunderstandings. It is also our desire to have clauses which definitely restrict the irresponsible contractor from prosecuting his work in an unskillful manner and attempting evasion of clauses covering honest construction. We believe that there is a necessity for intelligent and trained supervision, and realize that a favorite clause in specifications which provides that the contractor shall make good any defects, even though the work has been inspected, could be strengthened to the advantage of both parties by providing that the owner shall furnish competent inspectors, rather than men who get positions because of political influence. An inspector of experience and engineering training who is fair minded is often able to adjust without a wrangle questions, the settlement of which in the hands of an incompetent representative of the engineer in charge would cause trouble between the engineer and the contractor.

Employer-Employee Relations.—Many specifications covering public works construction provide restrictions on the contractor in relation to his employees. These clauses restrict the contractor to the number of hours which shall constitute a day's work and a week's work, and also provide a minimum rate of pay. Despite the fact that such restrictive clauses are made a part of the contract, some contractors are permitted to openly violate them, while others are held strictly to their enforcement. If incorporated communities recognize the law covering such restrictions and embody them in their specifications, it is fair to those contractors who have submitted bids for such work and who intend to live up to these clauses, that these communities should also act when these clauses are disregarded.

We are pleased to note that several specifications which have recently been issued contain a clause covering arbitration. The American Institute of Architects and the Federated American Engineering Societies recognize the principle of arbitration in their present standard building contract form, and we believe that this is one of the most vital matters which has come to our attention in connection with our study of the relation between owner and contractor. No fair-minded engineer questions the right of the contractor to present his side in a dispute, who would gladly submit his case to a board of arbitration as provided for in a contract, unless he willfully intended to evade his responsibility. We are therefore in favor of embodying in the general clauses of the contract a provision for arbitration which will provide for a settlement, as far as possible, of all disputes which may arise in the interpretation of specifications or in the execution of the contract.

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*[illegible] Engineers' [illegible]

What of Concrete Aggregates?—We believe that specifications covering the proportioning of the aggregates used in mixing concrete should be simplified and strengthened. The responsible contractor bases his estimate on the use of satisfactory material; the irresponsible contractor generally figures on the cheapest material it is possible to buy, regardless of its quality, and hopes by some means to have this material passed if he secures the contract. Because of the conditions existing at different places, as far as variety of materials is concerned, specifications should definitely cover the quality desired by the owner, and there should be no opportunity for the irresponsible contractor to become misled through the specifications. It should be the duty of every reputable engineer to thoroughly investigate the quality of the materials available for his work, so that he may definitely specify what is to be used. The specifications covering the proportioning of the aggregates should be carefully drawn. Many times expensive cement is wasted because of the indifference of those interested in the proper proportioning of the aggregates. If this was given careful attention the reputable building supply dealers in the various communities would of necessity have accurate information for the contractor as to the weight of the aggregates per cubic yard, the percentage of voids contained in such commodities as gravel, crushed stone and slag, and would also furnish through their sales department a report on the character and quality of the material.

For a Great Clearing House of Construction Information

Recommendation by the American Section of the Committee on Construction of the International Chamber of Commerce

The American Section, acting upon recommendations made by the International Chamber of Commerce at its meeting in London in June and July, 1921, has now submitted its report on this subject. The recommendations under which it acted were:

> "1. Appoint a permanent committee to undertake a survey of the Construction Industry which shall proceed along the lines of collecting, collating and disseminating the vast amount of valuable data which is at present in the possession of such agencies as the British Engineering Standards Association, the Royal Institute of British Architects, the French Ministry of Commerce; the Office de Batiment in Paris, the International Bibliographical Institute of Brussels; the Advisory Committee of the American Federation of Labor, the National Federation of Construction Industries of the United States, the Associated General Contractors of America, and a number of similar agencies operating in different countries.
>
> "2. Subject to the availability of funds which can be used for the purpose, provide a necessary staff for carrying out the work described above."

The American Committee consisted of Noble Foster Hoggson, New York, chairman; Col. John R. Wiggins, Philadelphia, Pa., and Col. F. W. Abbott, Paris, France. What follows is taken from the report.

American Survey Begun.—In line with the purpose expressed in this resolution, the American Section of the Committee on Construction has devised a plan to meet the requirements of the construction industry in America, and it is the hope and belief of the committee that the same plan with perhaps some modifications can be adopted to advantage in other countries.

If other member countries will put such a plan into operation and report to the headquarters of the International Chamber of Commerce, it will not be long before the hope of the Committee on Construction for a continuing survey will be realized.

It is very gratifying to be able to state that the Associated General Contractors of America, an organization representing 1,200 of the leading construction firms of the United States, has had the business foresight to see the value which the proposed Survey of Construction and Service Bureau will have for the construction industry in America, and beginning Oct., 1921, has put such a plan into operation. The first six months' work shows very satisfactory developments and promise of increasing value and importance, not only to the constructors of the country but also to bankers, manufacturers, engineers, architects, technical schools, and editors.

Plan Applied to Construction.—The Service Bureau is functioning in the following manner:

Functions of Service Bureau:

a—Obtaining, assembling and correlating data of active interest to all branches of the construction industry.
b—Preparing and filing the original and analyzed data in convenient form for active use.
c—Studying interrelationships of such data and discovering their significance.
d—Presenting this data in graphic and tabular form with explanatory notes through weekly reports to those interested in construction in its various branches.
e—Acting as an information or service bureau for the construction industry, to furnish quickly special information as required by individuals.

Classes of Statistics Presented.—The principal classes of statistics which the bureau of the Associated General Contractors is collecting, follow:

Fundamental Construction Statistics:
1—Materials of construction—
  a—Production.
  b—Shipment.
  c—Stocks.
  d—Prices at mill.
  f—Prices at point of consumption.
  (Figures corrected occasionally showing resources by location and quantity.)
2—Labor
  a—Number of people employed in the construction industry, by trades and locations.
  b—Wages and hours.
  c—Immigration and emigration.
  d—Local labor agreement conditions.
3—Products of Construction—
  (By location and class of construction.)
  a—Contracts let.
  b—Building permits issued.
  c—Value of contracts in progress.
  d—Demand in near future.
4—Transportation—
  a—Cars in use.
  b—Car shortage and surplus (by kind of car)
  c—Car loadings.
  d—Ton miles.
  e—Railroad earnings.
5—Finance.
  a—Interest rates.
  b—Bank clearings and debits.
  c—Bank deposits and reserves.
  d—Exchange rates.
6—Economics—
  a—Wholesale and retail price indices.
  b—Cost of living.
  c—Stock market prices.
  d—Ability to secure loans and charges for same.
  e—Various indices of business acticity as these affect construction.

As far as practical, this information is gathered regularly—weekly, monthly, or quarterly as the case may be—in order to interpret properly seasonal and local variations, note exceptions, and indicate trends.

Derived Statistics.—On the basis of this and similar data, the bureau computes many derived statistics—some of them monthly, some quarterly or yearly, and some occasionally. Examples follow:

a—Indices of construction costs for the country as a whole and for localities, subrivided into material costs and labor costs.
b—Production versus requirements.

c—Costs to consumer versus production costs
d—Effect of freight rates and costs
e—Effect of immigration laws on labor supply
f—Prospective adequacy of transportation facilities
g—Prospective demands for construction by kind and place

Sources of Data. The bureau utilizes to the fullest possible extent all existing agencies for the collection of data. It aims to be a collating and analyzing rather than a collecting agency. Existing sources fall into the following four classes:

a—Governmental, Federal, State and Municipal
b—Business publications
c—Business associations
d—Individual firms and corporations

Practical Value of Service. The practical value of the service of this bureau as it develops to individual firms interested in construction is unlimited. Not only may any firm interested in construction keep informed on the trend of price, wages, cost, etc., in order to more intelligently size up their own individual problems, but actual service may be rendered in connection with such individual problems. Such service will require time and effort to perfect, but it is quite within reason to picture a central source of information on construction to which one may turn for immediate, accurate and reliable information on any subject affecting construction.

For example: A contractor proposes to bid upon a building job at Dunkirk, N. Y. Prices can be made available on materials and labor of practically all classes for some nearby large city such as Buffalo, N. Y. Special prices for steel can be had f. o. b. Pittsburgh. Mileage and freight rates can be readily secured. Costs of living for employes who must be sent to the job and maintained there can be ascertained. Interest rates charged by banks for loans such as might be obtained locally, with the contract as collateral, can be obtained. Reports of stock on hand at different points will indicate where probabilities exist of buying to the best advantage. Reports of unemployment will show possibilities of securing labor locally or at the nearby main centers. Reports of contracts let will indicate the amount of competition of labor and materials which can be expected. The number and value of building permits issued will indicate the possibilities of securing other jobs in the same district, so that overhead can be reduced and extra profits secured or greater reductions made in bids. Comparisons of statistics for earlier months will render the preparation of bids much easier in districts where bids have already been prepared some months previously, and where contracts are actually under way so that accurate comparisons can be made between the public statistics and figures secured in actual work locally.

In fact, with such a burden functioning at full capacity, a contractor may ask for a report in such a case which, at slight expense, will give him invaluable information affecting his bid. Such service is being rendered in other fields of business. It remains only for the construction industry to develop a central agency to be able to have such advantages also.

Take another example: a terra cotta manufacturer wishes to decide as to the best market in which to concentrate his selling campaign. Prices for various terra cotta products may be made available weekly for all the principal markets, car loadings will indicate by districts where car shortages have been experienced, and comparisons with previous years will show what seasonal variations are likely to occur; [illegible] and value of building permits over considerable periods will indicate cities and districts in which building has been active and where it has been inactive but is [illegible] to do so. Interest rates will indicate the amount of discount which the manufacturer must expect to [illegible] if he discounts notes received from terra cotta purchasers in the [illegible] market, and [illegible] with the many questions which must be answered before a final decision [illegible].

[illegible] has desired to compare building costs in a certain [illegible] with those in adjacent cities and the country at large. [illegible] quantity lists on buildings of various types such as small residences, [illegible] buildings or manufacturing plants are available [illegible]. A [illegible] can [illegible] by using the same quantities with current material and labor prices from the cities in question will give an immediate answer to the question. If material prices are high, the statistical service can begin to investigate the reason by comparing stocks on hand at various points, the amount of unemployment, the wage rates, the cost of living, the interest rates, and other factors.

Results Obtained in Six Months. The point is that, with the wealth of information which now exists affecting construction, a bureau such as this, properly manned by specialists who are devoting their time to discovering all possible sources and data relating to construction, can give the industry immediate and reliable service which no single individual can attempt to provide. This service the Associated General Contractors of America has begun to develop.

The improved character and wide scope of such a service has been obvious as compared with the meager information gathered by individual firms, or presented irregularly and not readily accessible in the trade press. The response from constructors has been very generous. Of the 1,200 members of the Associated General Contractors, approximately 200 from all parts of the country have already agreed to supply information regularly as to prices, wages and conditions in their localities, on forms supplied by the bureau.

Statistics Create Wide Interest.—Naturally, the attention of others interested in construction has been attracted to the reports, and beginning Jan. 1, 1922, subscription to Index has been opened to others than members of the Associated General Contractors of America, architects, engineers, bankers, manufacturers, labor officials and editors have expressed keen interest in the reports. The attention of the American Federation of Labor has been attracted by data presented relative to labor and especially by the analyses of construction wages and the cost of living, which have brought to light many discrepancies and furnished the basis for an intelligent and fair basis of adjustment.

Engineers and architects are finding the data presented of value both in consultation work and in the preparation of estimates for clients; manufacturers in the analysis of market conditions and price trends, and in the preparation of sales campaigns and sales literature. Bankers and allied interests are welcoming such statistical information specifically applied to construction, as an aid to them in determining the value of construction investments. Opportunity to take advantage of the service is being extended to all other associations in the construction industry, including contractors, sub-contractors, material manufacturers and dealers, real estate operators, and to chambers of commerce and the daily press whose interest in such information is obvious as part of their activity in inaugurating housing campaigns, accelerating public improvements and industrial development, and determining local employment and wage conditions. Several colleges and universities have also placed the service in their libraries for use in connection with their technical courses.

In these ways the bureau already is providing a better knowledge of construction conditions among those most directly connected with it, which will result in more accurate, and consequently lower, bids; and through the influence of the trade and daily press a greater confidence in costs and prices is being engendered with the consequent restoration of public confidence and general prosperity.

World Service for All Industries. The experiment which is being tried out in the construction industry is capable of extension to all the major industries in America, including textiles, leather, metals, food stuffs, furniture, mining, agriculture, etc., etc. To create a similar bureau in each industry, in line with Secretary Hoover's policy in connection with the department of Commerce, and to pool the information and data in the department for the benefit of the whole country will inevitably be of immense value.

Similarly, the plan may be extended to other nations. If associations in England, France, Belgium, Italy, etc., similar to the Associated General Contractors of America, will assume responsibility for developing bureaus serving their particular industries, and in each country ultimately extend this to include all major industries, there would soon be developed, at comparatively slight cost, the foundations for a great international exchange of information through the International Chamber of Commerce. The possibilities for great industrial progress through such an exchange of information are unlimited.

Indeterminate Structures Mechanically Analyzed

Results by Mechanical Method Give Remarkable Check with Theory, and Provide Great Reduction in Labor

Tests with Paper and Celluloid Models of Various Structures Described in Detail*

By GEORGE ERLE BEGGS,
Assistant Professor of Civil Engineering, Princeton University.

During the summer of 1916 my attention was given to the problem of the deflections and stresses of the triple span continuous trusses of the new B. & L. E. R. R. bridge over the Allegheny River. One of these trusses is shown in Fig. 1. On account of the various conditions of loading for which it was necessary to calculate the four-truss reactions, it was considered advantageous to construct their influence lines, after calculating their ordinates by the theories of deflection and least work. These influence lines, plotted in Fig 1, resembled the elastic curves of continuous beams fastened at three supports and deflected a unit distance at the remaining support for whose reaction the influence line was drawn. To determine the accuracy of this observation, a 10-ft. pole of uniform section and three nails were used. To draw the influence line for R_1, the pole was restrained by single nails at R_2, R_3, R_4, and deflected at R_1, a distance to scale 1,000 lb. The ordinates to this elastic curve were measured.

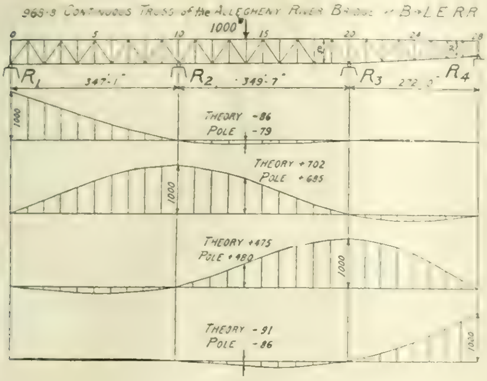

Fig. 1.

COMPARISON OF INFLUENCE LINE ORDINATES
OBTAINED BY THEORY AND BY POLE
FOR THE 968-8" CONTINUOUS TRUSS OF B.&L.E Br
CALCULATED FOR A UNIT LOAD OF 1000#

LOADED POINT	R1		R2		R3		R4	
	THEORY	POLE	THEORY	POLE	THEORY	POLE	THEORY	POLE
0	1000	1000	0	0	0	0	0	0
1	+ 881	879	+ 142	149	− 28	35	− 5	6
2	760	754	287	307	− 55	71	8	13
3	641	633	428	450	− 83	104	13	22
4	526	518	561	585	− 103	128	17	27
5	414	404	687	717	− 120	148	20	29
6	309	302	798	825	− 128	150	21	23
7	216	209	880	910	− 113	139	17	30
8	134	124	942	977	− 89	115	13	22
9	62	57	981	1008	− 49	68	7	12
10	0	0	1000	1000	0	0	0	0
11	− 37	40	956	965	+ 105	102	− 24	− 25
12	− 64	− 63	890	894	223	218	49	46
13	81	− 78	807	798	346	345	71	− 68
14	− 86	− 79	702	685	475	480	91	− 86
15	79	− 75	573	560	613	619	107	100
16	67	63	445	435	736	738	115	109
17	49	48	313	312	845	842	103	105
18	32	− 32	195	187	924	930	86	89
19	13	13	85	82	980	981	52	− 54
20	0	0	0	0	1000	1000	0	0
21	− 9	9	− 58	− 51	974	965	+ 74	74
22	15	17	− 97	− 80	917	895	165	169
23	19	18	− 121	− 95	834	792	266	282
24	18	18	− 120	− 95	710	665	392	409
25	16	17	− 105	− 79	557	520	531	545
26	11	12	− 75	− 55	381	350	662	690
27	8	7	− 45	− 32	201	180	836	840
28	0	0	0	0	0	0	1000	1000

Fig. 2.

The comparison of values obtained by this crude mechanical apparatus and by exact theory are given in Fig. 2. The agreement of values is seen to be remarkably good.†

The fundamental principle of any mechanical solution is Maxwell's Theorem of Reciprocal Deflections, as proved and applied in all texts on higher structures. Consider the very complicated structure shown in Fig. 3. Suppose in the first instance that this figure represents the actual full-sized structure. Let it be required to find the horizontal thrust at the hinge at the foot of the third column, caused by a load P on the first arch. Assume for the sake of argument that the third support is changed from hinged to roller bearing, so that horizontal motion may occur freely. Attach to the lower end of the column a cable which carries a weight H. This weight is such that it holds the column from deflecting horizontally when the load P rests on the arch. Now attach to the right hand cable shown a pail carrying a very small load f pounds of sand. From the weight H hang an empty pail. The foot of column deflects a small distance 0.5 d_1 from point 3 to point 1, and at the same time the load P is moved from point 6 to some point 7. Now transfer the sand f to the pail at left of 3. The column deflects a horizontal distance d_1 from 1 to 2, while the load P moves from point 7 to 8. From Maxwell's Theorem, it follows that

H equals P $\left(\frac{d_2}{d_1}\right)$

It is to be noted that in general the value d_2 is the component of the deflection of P in the direction of P. It is evident from this equation that H becomes known as soon as the ratio d_2/d_1 is evaluated, and the load P specified. It is further apparent that this ratio of deflections may be obtained by applying to an elastic unloaded model of the actual structure a small deflection d_1 and measuring by accurate means the corresponding deflection d_2. There is an advantage in introducing the deflection d_1, half to the right and half to the left of the mean position, for the frame is distorted from its geometric position less than if the deflection were all on the same side of the mean geometric position.

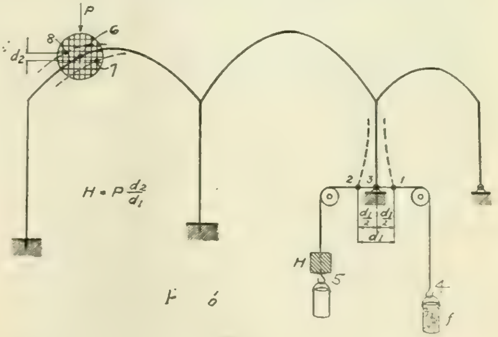

Fig. 3.

Assume in the second instance that it is desired to know the bending moment at the foot of the second column due to a load P on the first arch (Fig. 4). Assume that the connection of this second column is changed from fixed to hinged. Let the hinge pin be a shaft keyed to the foot of this column and turning freely in a bearing that is fixed to the foundation. On this same shaft mount a wheel of 1 ft. radius as shown. Support by a cable wound on the circumference of this wheel a weight M of such value that the foot of this column is not rotated from its vertical position when the load P rests on the first arc. Attached to the right hand end is a pail carrying a very small load f pounds of sand, and from the weight M hang an empty pail as shown. The circumference of the wheel deflects a small distance 0.5 d, clockwise and at the same time the load P is moved downward and toward the right. The motion shown by the drawing is greatly magnified. Now transfer the sand f to the empty pail. The circumference of the wheel will deflect a distance d counterclockwise, and at the same time the load P will move upward and toward the left, the component of its motion in the direction of P being d. From Maxwell's Theorem it follows that

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†The author next refers to some significant tests made by Mr. R. Fleming of the American Bridge Co. in 1919, and then gives an example and comments on the cumbersomeness of the well-known method of slope deflections.—EDITOR.

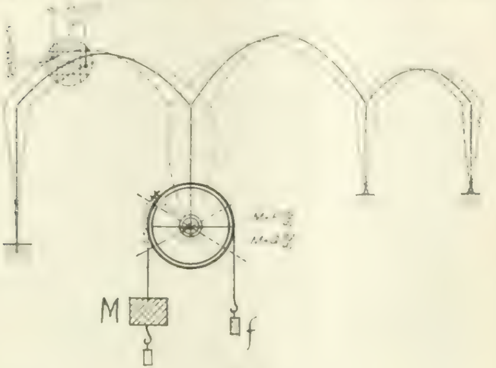


Fig. 4.

$$M = Pd_2/d_1.$$

It is evident that the value of the weight M that will produce elastic equilibrium becomes known as soon as the ratio of d_2 to d_1 is evaluated and the load P specified. It is also apparent that this ratio may be obtained by applying to an elastic unloaded model of this structure a corresponding small rotative deflection d_1 and measuring by accurate means the corresponding deflection d_2.

It is further clear that the value of the weight M is numerically equal to the bending moment at the foot of the second column, since the radius of the wheel is unity. As before and for the same reason, the deflection d_1 is applied half on either side from the mean geometric position.

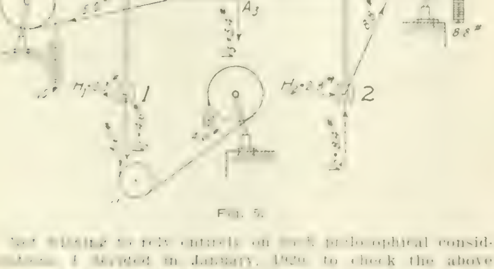


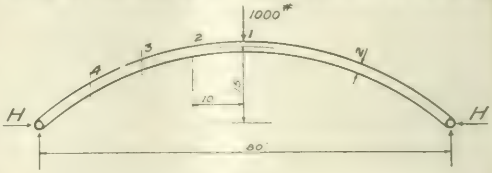
Fig. 5.

Not wishing to rely entirely on such philosophical considerations, I decided in January, 1920, to check the above principle by a practical test.

A model of an indeterminate structure of the form shown in Fig. 5 was constructed. The frame was made of wood strips about [illegible] by [illegible] in., the columns and main horizontal member being [illegible] in. in length center to center of connections. Metal plates and screws fastened the bars together. The three-hinged frame was supported in a horizontal position on the floor and floated on ball bearings that moved freely between glass plates. While measuring deflections no weights were applied to the structure. In order to determine by deflections the value of V_3 at support 3 that would be caused by a load P equal to 12 lb., the ratio d_1/d_3 was first determined as follows: the pin at 3 was removed and the point 3 of frame forced to deflect vertically upward by an amount 0.5 d_3 and then vertically downward by the same amount. The corresponding motion of point B_1 was to A_1, and its deflection d_1 was measured. According to the principle previously explained, V_3 equals $d_1/d_3 \times 12$ lb., in which equation the ratio of the known values d_1 and d_3 was such that V_3 was calculated to be 3.4 lb. By similar method H_3 was calculated to be 14.6 lb. The total reaction at 3 for P equal to 12 lb. was thus completely determined, its value 15 lb. being equal to

$$\sqrt{14.6^2 + 3.4^2}$$

The pin was replaced in hinge 3. The load P equal to 12 lb. was applied by means of a counterweight acting through a cord wound over a bicycle wheel as shown in Fig. 5. A force of 15 lb. was similarly applied in the line of the resultant of H_3 and V_3 by a cord attached to a screw in the bar close to point 3. The pin at hinge 3 was then removed. To my great satisfaction no deflection occurred upon removal of this pin. The reaction of 15 lb. at hinge 3 as determined mechanically, was therefore correct, for it produced both static and elastic equilibrium. Similarly the reactions at hinges 1 and 2 were determined, and their correctness tested. The three reactions as determined entirely by deflection measurements are seen to satisfy very well the three laws of statical equilibrium. The small errors may be chargeable to the crudeness of the apparatus.



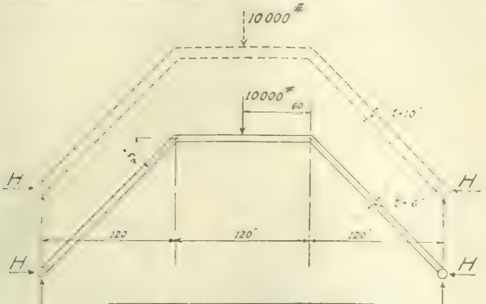
1000# at	H	
	Model	Theory
1	1000	1000
2	920	930
3	720	720
4	420	400

Fig. 6.

In order to reduce the scale of the models and at the same time to improve the accuracy of the observations, it was soon decided to make the models of celluloid, and to read the deflections by use of micrometer microscopes. These microscopes will read directly to about 1/16000 of an inch. They are of a stock pattern except for the cross section lining in the field of view.

The first structure solved by aid of the microscope was an arch similar to that shown in Fig. 6. A celluloid model of this arch to scale span equals 6 in. was placed on the drawing board. The right hinge pin was made immovable, and the left hinge pin was allowed horizontal motion. The arch floated on small ball bearings placed between it and the drawing board. One microscope was placed over the left hinge and oriented to read its horizontal motion. The other microscope was placed over the point of application of the vertical load and oriented to read the vertical component of the deflection of the load point. The experiment was most encouraging. The ratio of the measured vertical deflection of the load point to the horizontal motion of hinge multiplied by 50,000 gave H equal to 44,600 lb. as compared to 44,800 given by the common theory.

The practical difficulty of the method was the making of the celluloid models. At the suggestion of one of my students, I decided to use heavy paper or cardboard for model making. The thickness chosen can be cut with a few heavy strokes of the penknife. Needles pressed through the paper make very satisfactory hinges. A model of the two-hinged arch shown in Fig. 6 was made of paper to scale span equal to 20 in. The values of H obtained from the deflection of this paper model read through the microscope compare very closely with those given by the common theory. Models of several other structures were also made of thick paper, and the reactions found by deflection readings agreed as closely as might be expected. A little consideration will show that as the depth of the rib increases, the value of H should decrease, until the reactions become almost entirely vertical when the rib is several feet deep. The effect of the increase of the depth of rib on the reduction of H is shown by the results in Fig. 7.

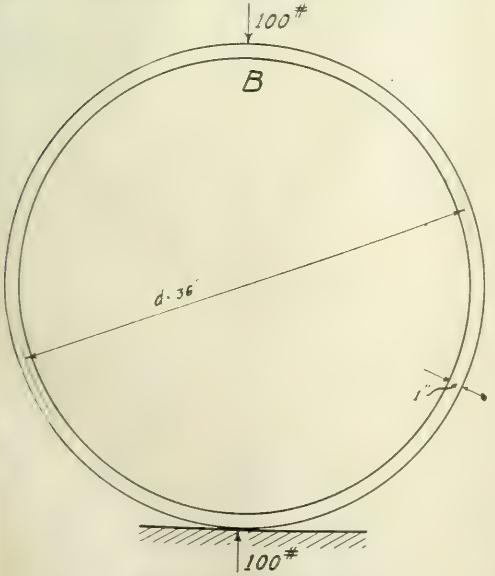


H	t	Paper Model	Theory
	6"	5530	5637
	10	5430	5637

Fig. 7.

The difference between results by model and theory for the ring in Fig. 8 may be partly chargeable to the approximations in the mathematical analysis. In any case, the error is negligible for practical purposes.

The paper model of the arch with fixed ends shown in Fig. 9 was made to scale span equal to 20 in. The right end was fastened to the drawing board and the left end glued to a movable block. The model was floated on small ball bearings. Unit, moment, thrust, and shear deformations were introduced in succession at the left support, where one micrometer microscope was used to measure the motion of the foundation. The second microscope was used to read the vertical components of the deflections of the rib. These latter deflections are directly proportional to the influence line ordinates for the moment, shear, and thrust at the left support of the arch. The small variations between the dotted and full influence lines in Fig. 9 indicate the close agreement of the values read from the paper model with those obtained by theory. A record of the numerical values by the two methods is given in Fig. 10.



M_B	Paper Model	Theory
	590	572.4

Fig. 8.

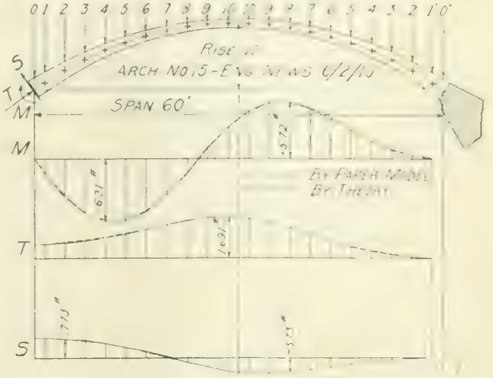


Fig. 9.

In order to bring the theory into agreement with the results read from the model, it was necessary to apply to the values obtained by theory the correction for thrust shortening. The two solutions agree quite closely enough for practical design. There are strong reasons for believing that the mechanical solution is fully as near the truth as is the theoretical solution.

Deformeter Gage.—The final development in the mechanical method was the design and application of the deformeter gage shown in Fig. 11. The function of this gage is to introduce at any section of the model, either at the support or at any other section of the structure, a unit deformation. This may be a pure thrust, shear, or moment deformation. Suppose, for example, that it is desired to obtain the thrust at the fixed end of some member M of any indeterminate structure due to a load P applied at some point A of the same structure and acting in the direction CA. These latter points appear in the field of the micrometer microscope set up over some load point A of the model structure. The cross lines of the microscope field are oriented in the direction CA of the applied load P which direction is penciled on the model for convenience in orienting the microscope. At the fixed support the paper model M is clamped to the gage by means of the plate d. The model floats freely on small ball bearings. The bar a of the gage is fastened to the drawing board by means of the phonograph needles n, a thin piece

COMPARISON OF VALUES OBTAINED BY THEORY AND BY PAPER MODEL
FOR ARCH NO 15 ENG NEWS 6-2-10
EFFECT OF THRUST SHORTENING INCLUDED IN BOTH CASES

LOADED POINT	MOMENT		THRUST		SHEAR	
	THEORY	MODEL	THEORY	MODEL	THEORY	MODEL
0	-0 00	-0.00	+ .584	+ 584	+ 807	+.807
1	- 1.50	· 1 38	.585	.590	.810	780
2	- 3 86	- 3 70	.626	.660	.773	.785
3	- 5 49	- 5 60	706	.737	.700	.680
4	- 631	- 6 18	.828	.848	.586	.588
5	- 6.24	- 6 02	982	1.015	430	.420
6	- 5.30	- 5.28	1 168	1.175	.240	219
7	- 3 63	- 3 33	1 353	1 365	300	.030
8	- 1 40	- 1.29	1 515	1.540	- 182	-.191
9	+ 1.04	+ 1 17	1 645	1 635	- .388	-.364
10	3 25	3 13	1 691	1 675	- .539	- 522
10'	4.87	4 64	1 628	1 625	- .627	-.610
9'	5 67	5 70	1 466	1.470	- 632	-.612
8'	5.72	5.71	1 232	1.245	- 573	- 570
7'	5 06	5.14	980	990	- .486	- 494
6	4.07	4 24	.726	.750	- .375	-.383
5'	2 89	3.19	482	503	- 260	-.272
4'	1 80	2.00	285	325	- 159	-.177
3	0.93	1 00	140	.175	-.080	-.089
2'	0.31	0 51	.043	061	- 028	-.033
1'	0 00	0 03	.000	004	- .000	-.007
0	0 00	0 00	.000	.000	- .000	-.000

Fig. 10.

of paper t being used between c and the drawing board so that the bar b may have clearance and free motion. For hinged supports the plate d is omitted and the pin h in bar b acts as the hinge pin. If the thrust at the fixed support due to a load P acting in direction CA at A is desired, remove the two round normal plugs of the deformeter gage with two small wooden wedges and insert in the gage the larger pair of thrust plugs shown. Read in the microscope the position of the load point A of the model. Next place the pair of smaller thrust plugs in the gage. The load point A is seen in the microscope to move along a straight line to a point B. Take reading of the position B, and by difference obtain the deflection AC = d. If the total thrust deformation introduced by the standard deformeter gage be d_1, the value of the thrust at the support in question equals (d/d_1) P, and is a compression, for the upward deflection at the support has caused the load point A to deflect in a direction opposite to the direction CA of the applied load. The mechanical method therefore gives both the sign and value of the desired component of the reaction. To obtain the moment and shear at the same section, the moment and shear plugs are used in the gage in similar manner and values of moment and shear are calculated from the two corresponding deflection measurements made with the microscope.

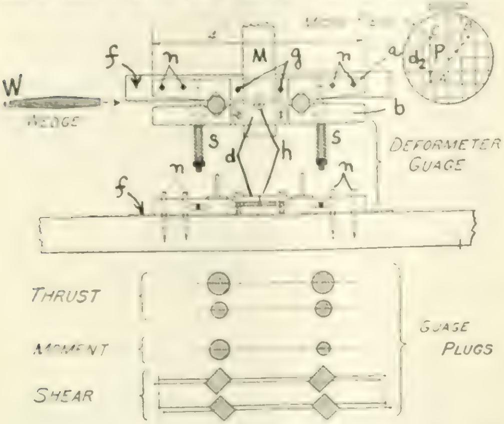
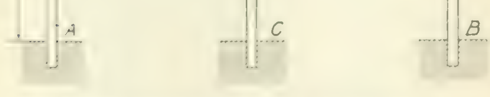


Fig. 11.

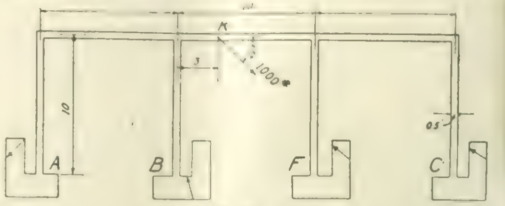
If the moment, shear, and thrust at some interior section of an internally indeterminate structure must be found, the gage is clamped at such section by means of two bars d, one as shown in Fig. 11, and another bar d by screws in holes g. The gage in this case floats on three ball bearings which move freely between two thin glass plates. The model is cut at this section. The three sets of plugs for moment, shear and thrust are then introduced in succession, the corresponding deflections of the load points of the model are read through the microscope, and the corresponding moment, thrust, and shear at the section evaluated as before. The values shown in the following five illustrations and also for a single span beam with fixed ends were obtained by use of small scale paper models. (Scale 1 in. = 1 ft.) The deflections were introduced by the standard deformeter gages and the deflection of the load points read through the microscope.



	Paper Model				Theory		
	A	C	B	Ck	A	C	B
H	301	390	309	ΣH·10	302	396	302
V	238	10	225	ΣV·3	219	0	219
M	[illegible]	1935	[illegible]	ΣM·[illegible]	1771	2084	1771

Fig. 12.

For the single beam the deformeter gage was attached at one end and the microscope oriented to read vertical deflection at the center of span caused by the small rotation at the end produced by reversal of the moment plugs in the gage. The agreement of the two results for moment at the support is satisfactory.—Paper Model 1,230 lb., Theory P. 2/8, 1,250 lb.



A B F C FIXED

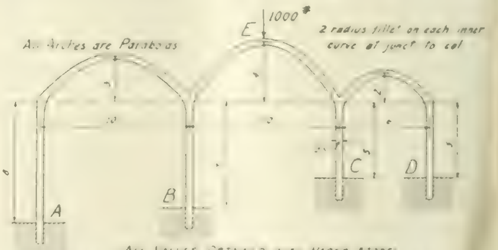
	Paper Model			Theory		
	H	V	M	H	V	M
A	168	173	915	176	165	992
B	150	630	915	142	611	877
F	206	148	1000	236	164	1189
C	165	106	945	153	96	914
Ck.	ΣH·18	ΣV·4	M·18			

Fig. 13.

In Fig. 12, the deformeter gages were attached at the three supports A, C, B, and the three components of reactions determined by reading the horizontal deflections of model at the load point D. The forces and couples at A, C, D, so determined together with the load at D are found to satisfy the three equations of equilibrium with remarkable precision.

The components of the reactions of the four-post portal in Fig. 13 were similarly determined both by model and by slope deflections.

The reactions calculated by the model deflections again satisfy very well the three laws of equilibrium and agree reasonably well with the values obtained by theory. There is no reason to believe that the theory values are more accurate than those obtained by the model. From the components of these four reactions, their magnitudes, directions and positions were calculated. A celluloid model of the structure was then made to a scale 1 in. = 1 ft. The lines of the reactions as determined from the deflections of the paper model were scribed on the extended foundations of this celluloid model as shown in Fig. 13. Holes were drilled along these lines and a single hinge pin out in each foundation anywhere along the line of its reaction. A varying



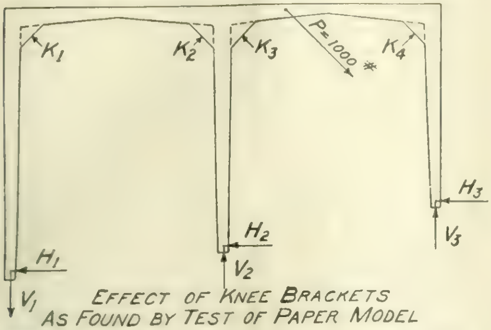
ALL VALUES OBTAINED WITH PAPER MODEL

	ABCD Fixed			AB Fixed, CD Hinged			ABCD Hinged		
	H	V	M	H	V	M	H	V	M
A	39	19	193	[illegible]	[illegible]	[illegible]	10	6	0
B	[illegible]	481	535	156	677	[illegible]	95	455	0
C	173	493	415	144	[illegible]	0	108	550	0
D	34	3	142	34	26	0	7	24	0
Ck	ΣH·1	ΣV·2	M_c·121	[illegible]	ΣV·13	[illegible]	[illegible]	ΣV·14	M_c·100

Fig. 14.

force was then applied at the point K in the direction shown, causing the structure to deflect throughout. None of the four foundations rotated appreciably on their single hinge pins. This is a practical proof of the correctness of position and direction of the reactions obtained by the deflection of the paper model.

The structure in Fig. 14 presents no more difficulty than the preceding one when solved mechanically. This problem was completely solved by reading the twelve deflections at point E corresponding to the H, V, and M displacements introduced successively by the four gages at fixed supports A, B, C, D. The effect of changing the supports from fixed to hinged was easily investigated after removing clamping bar from the gage (Fig. 11) and allowing the paper to turn freely on the hinge pin. The values of reactions obtained by deflections are seen to satisfy the three laws of equilibrium very closely.

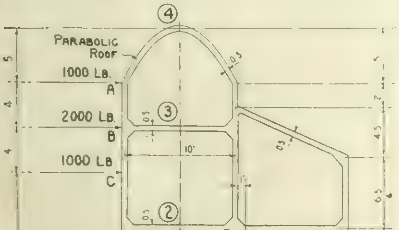


EFFECT OF KNEE BRACKETS AS FOUND BY TEST OF PAPER MODEL

BRACKET OUT	H_1	H_2	H_3	$H_1+H_2+H_3$
NONE	137	222	337	696
K_1, K_2	116	213	370	699
K_1, K_2, K_3	107	220	366	693
K_1, K_2, K_3, K_4	140	221	330	691

Fig. 15.

The structure shown in Fig. 15 was tested by deflections to determine the effect of knee brackets on the reactions. Note the great change in H_1 and H_3 as the four brackets are removed in succession. Any theory that omits the effect of knee brackets evidently may lead to large errors.



STRESSES BY PAPER MODEL

PT.	1	2	3	4	CHECKS
H	139 ←	1145 ←	2332 ←	380 ←	$\Sigma H = 4$ →
V	2080 ↓	1145 ⇅	654 ⇅	216 ⇅	$\Sigma V = 63$ ↓
M	0	277 ↻	184 ↻	688 ↺	$\Sigma M_B = 322$ ↻

$$\frac{\Sigma M_B}{4000} = \frac{322}{4000} = .08'$$

Fig. 16.

In order to show the generality of the model method, the reactions and internal stresses in the complex elastic structure in Fig. 16 were determined by model deflections and the results checked by the three laws of equilibrium applied to the portion of the structure to the left of the dotted section. Considering the magnitude of the applied loads, 4,000 lb. total, the check by statics is very satisfactory.

American Shortcomings. Comparison of two designs of similar concrete structures, one made in America under the assumption of partial continuity, and the other made in Leipzig under the assumption of full continuity leads to the conclusion that the American design is either structurally weak or structurally uneconomical as compared with the European design.

When it is remembered that the bending moment due to distributed load varies as the square of the effective span length, it is apparent that there is much greater strength and economy in the structure designed and built as a fully continuous structure. One reason why American engineers have not recognized or planned for greater continuity in their designing is because of the laborious mathematical work involved. If, however, the analysis by elastic models is demonstrated to be a practical method of solving the more difficult problems in concrete structures, and further if the designer may be assured of the strength and uniformity of the concrete, the hope may be expressed that in the near future the designer will be more ready to mold the most adaptable of materials, concrete, into a greater variety of stiff, strong, and economical structural forms than have yet been conceived or attempted.

Keeping Up with the Procession

Some excellent advice for the college graduate just entering upon his engineering career was given by Lenord Metcalf, of Metcalf & Eddy, consulting engineers, Boston, Mass., in an address last March to the seniors in Mechanical Engineering at Massachusetts Institute of Technology. The following abstract of the address is reprinted from The Tech Engineering News:

After the Institute, what? Have you thought of that subject really seriously, or are you only drifting? I assume that you would not be here if you did not have ambition; but what is your ambition? Are you looking forward to burning your books and finding a job that will pay you as much as possible? Are you planning to follow your father and "go him one better"? Are you out for adventure; or have you watched the world's leaders, the workers of the race, and planned your campaign along definite lines to broaden your vision, your experience, and increase your ultimate value by work which will count in those directions, rather than simply in the direction of increased income: by study of books and current literature, by contact with bigger minds, and by observation and comparative analysis of your work and that of others about you. You cannot float for long. It is either a case of sink or swim. If you try to float the lack of exercise will let the water chill you. You will get the cramp and sink. If you swim, will you be content to paddle around, or will you race your competitor?

The Field a Broad and Attractive One.—If you have any strong bent and are wise, you will follow your bent. Broadly speaking, there lie open to you, professional, administrative, and operating work with existing enterprises; purely professional work; teaching and editorial work; and invention.

Your first decision will be as to whether the professional, or commercial and administrative side of the problem interests you most. Both are attractive and afford equal opportunities. It is essentially a question of preference, though your preference may be limited by opportunity. In the first you deal with science; in the second, with men. If you select the professional field, then you must decide whether it shall be that of general practice or of practice in the field of a going concern. The former is more likely to lead to greater adventure and breadth of information, but also to the itinerant life of the professional hobo, so to speak; the second, to a more normal though perhaps more restricted life; but no man is free. If you select the administrative or operative field, you will work with an organization. You may do so in the professional field, but everything will be viewed from the impersonal view and demands of the organization. Relatively, so few enter the field of invention, teaching, and editorial work, attractive as they may be, that it is not necessary to dwell upon them in this discussion.

You can well afford to spend the next ten years, or thereabouts, in gathering breadth of experience, more or less regardless of your compensation during this period. The broader and deeper the foundations which you lay the more likely your final structure will be to develop fine proportions.

Consolidations in Selecting Your Work.—In selecting the individuals or the organizations with which you may choose to work, it will be advantageous for you to consider not only the kind of work but the character of the firm, the esprit de corps, the attitude of the employees and the opportunity for observing the work of others as well as playing your own part. You have had sufficient experience here in your college athletics to know the advantages of team play. In cold-blooded business it is not only advantageous but essential to develop it, and the lesson taught by The Three Musketeers shows clearly the greater pleasure which you will get out of life if you lead it with the idea of helpfulness to others always clearly in mind.

No man should be ashamed, even with the training which you have behind you, to begin at the bottom, for every man who has come "through the mill" recognizes the strength which comes from having carried his burden throughout the path traveled, and the advantage of occasionally helping the other fellow with his pack.

In stepping forward from the rear rank to the front rank, or from one position to another, you will be confronted with doubt as to whether it would be wiser to go or stay. If every time a doubt enters your mind you worry about it, you had better stay where you are. But if you think that every time it appears you can dispel it, you had better go, because you will be able to forward and develop both yourself and the business.

The General Administrative Problem.—When you leave the Institute you will not be likely to establish your own office immediately, because you have not yet had the experience which would make this advantageous, but I wish to point the way, and to tell you a little about the general administrative problem as experience has shown it to men who have succeeded.

There are two general methods of administration, one to build up the strongest organization that you can, even at the risk of being surpassed and elbowed out of it by better men; the other, to build up an organization of good fellows with cramped initiative.

If you pursue the first course your possibilities will be limited only by your success in judging and picking your associates and your staff. You will continue to grow and broaden, and you will experience the keenest of pleasures, that of constant intellectual stimulus. You will find opportunity to see more of life and nature, through having associates strong enough and trained enough to bear your load when you are absent. If you pursue the second course, your position may be safer from the point of view of permanency, but your output will be far more limited, the esprit de corps of your organization probably lower, and you will be constantly in danger of nervous wreck if your business grows and prospers. The leader sees what should be done and finds a way. The less successful man thinks first of safety and wonders what can be done.

Organizations Are Not the Growth of a Night.—If you examine organizations you will find that they have not grown over night; that they are the result of careful thought and planning. No mill, no business organization, can double its output quickly and maintain its old efficiency. The human and psychological factors are too important, the necessary checks and counter-checks too numerous, the inertia of the new idea, the influence of new conditions and of new environments are all too great. You must know your men as well as your machines, and must fit the one to the other.

What has made the J. P. Morgan organization so strong for so many years? "Money," you say. No, far from it—brains. It is the fact that Morgan had the shrewdness to see that continuous success was to be had only through periodic revitalization of his organization. He was in the favored position of being able to meet and judge of the men in the banking field. Again and again he drew into his firm new men, the ablest men that he could find, men drawn from the country to the cities, and often from the remote sections to the center of the financial world; men of initiative, of vision, of character, and of experience. The pace travelled was terrific, the responsibility which he threw upon them was tremendous. A decade was perhaps the usual limit of the individual, and then he retired with his stake, a handsome one of course, for the service which he had rendered was great, and he was succeeded by a new partner with fresh incentive and power, better attuned to the demands of his day, who went ahead under full steam. No wonder that under such a policy J. P. Morgan and Company have held their own.

Study, if you will, one of our most illustrious groups of men, making up Stone & Webster and its allied enterprises. I remember them when they were three young engineers just getting a foothold, who had the vision to see that there was a gap between the investor and certain public needs, which they could bridge. The bridge which they designed and built was strong, economical and well adapted to the traffic. It inspired public confidence, and as the loads which it was called upon to support grew, they stiffened the floor, then the girders, then rebuilt the structure again and again, to carry the increasing loads and to keep it well adapted to its work. They, too, studied their problem; they anticipated the conditions before they were faced with them. They did not wait for failure. So they have made a record of which any man might be proud.

Example of Different View Points. Let me contrast for you two examples of the effect of difference in point of view with regard to administrative organization methods already referred to. One, of the man who calls to his aid the strongest men that he can find, who studies his problem as one of research, who is beloved and respected by his fellow men, and who has made a wonderful record in the civil and mechanical engineering and in the insurance fields; the other, of a man who kept his knowledge to himself, surrounded himself with a loyal group of employes, rather than with associates, and who also left a record of splendid engineering service, but not of an organization which could carry on his work after he was gone. Each a producer, each a master of his subject, but with the striking difference, that the first became a leader of men, generous, to his confreres and assistants, sought by the younger as well as by the older men; the second, isolated, bitter, unrecognized, and unsought by his professional brothers.

The first may be known to you. John R. Freeman of the Class of '76—President of the largest group of Manufacturers' Mutual Fire Insurance Companies, consulting engineer on the Charles River Dam of the Metropolitan Water Board of Boston, on the Greater Water Supply of New York City, on the Hetch-Hetchy project of the City of San Francisco, on the rebuilding of the Grand Canal and control of floods on certain of the large rivers of China, and on many other projects; a past president of the American Society of Mechanical Engineers, and at the moment president of the American Society of Civil Engineers. He has commanded the confidence of the financial world, and is known by engineers as one of the ablest of our investigators of special engineering problems. This means that he is a master in the field of applied science, and knows the importance of the financial side of the problem.

The second is unknown to you and to this territory, no longer living, but a very able man in his time, who has left a splendid record of engineering service behind him. The keynote to his administrative views was given in the comment made one day by him to a fellow engineer whom he was showing over some of his large works, when, after meeting and chatting with one of his men, he turned to his friend and said: "That man is most useful to me. He does exactly as I tell him." He valued the ability to follow more highly than to initiate.

What has lain at the root of Freeman's success? Indomitable work, an open and acquisitive mind, character, courteous relationship with other men, and generous recognition of their worth and work. No wonder that he is respected by other engineers. And with the other man, what was the cause of his failure to receive greater recognition from his professional brothers? Professional jealousy and failure to stimulate, encourage, and applaud the advance of those about or under him, and to give credit where credit was due.

How to Broaden Your Outlook.—To what was, or is, Carnegie's, Schwab's, Vail's, or Stone's success due? It is due to work, to knowledge of men, to vision and to character. What then can you do to broaden your outlook and your prospects as you enter your life work? First, get an aim in life, if you haven't one already, and with it a hobby to ride; second, study men; third, don't burn your old books, but look upon them as friends in time of need, rather get more books and study them, that you may keep pace with progressive development; fourth, keep up with current technical literature, particularly in your own field, and broaden your field as much as you can, follow Roosevelt's lead in making it a point to do a bit of good reading daily, to come into contact with a better mind; fifth, join and take an active part in the proceedings of some professional society one working in your chosen field—to broaden your interest, information and acquaintanceship; sixth, interest yourself, as far as circumstances will permit, in public service work, for it will give you a new point of view and a wider circle of friends and acquaintances having different interests from your own; seventh, keep an open acquisitive mind; beware of your mental attitude, and let it always be constructive and not destructive in its influence—any man can criticize, but the percentage who can build up and better existing conditions is small.

It has been my good fortune to be more or less closely in touch with various technical societies in the past, and to know their activities and aims. They offer you advantages that you cannot afford to ignore.

Finally, be sure that you do not overlook the effect of personality upon success. In professional, as in commercial dealings, personality counts. Men like to do business with men whom they like and whom they remember because they liked and respected them, as well as because they recognized their technical attainments. Luck is rarely a determinative factor in man's success. Your future will depend upon alertness, steadfastness of purpose, hard work, and straight thinking. No influence can make good the lack of these. The fact that you have survived in the intellectual struggle of the four years of this institution is to your credit, but you will find that this struggle is but the beginning of a yet greater struggle for higher goals commensurate with your greater strength. Face the struggle, then, with an open mind, with determination, and with a smile on your face, and you will reach your goal. I wish you God-speed.

What Interests Engineers and What They Want at Their Meetings

Members of Seattle Chapter A. A. E. Express Their Preferences

A study of the kind of meetings members want was made by the Seattle Chapter. Returns from questionnaires asking the preference of members were as follows:

	Weighted total
1. Activities for meetings	
Civic enterprises	167
Industrial enterprises	93
Power and utility projects	89
Roads, highways and bridges	85
Railroads and street railways	55
Radio, telephone and telegraph	48
2. Outside speakers on following classes of subjects:	
Engineering	134
Banking	[illegible]
Elements of success	[illegible]
Political	50
Efficiency	48
Psychology	43
Chamber of Commerce	22
3. Trips to industrial plants on Saturday afternoons (Kind of plants preferred.)	
Construction projects	78
Manufacturing plants	71
Electric, steam and hydraulic	62
University laboratories	31
Highways	31
Buildings	28
Shipbuilding and repairs	24
Newspaper	15
Street railway repair	13
Canning	11
Candy	3
Mattress	3
4. Social affairs.	
Music	81
Dinners	77
Ladies' nights	49
Picnics	42
Trips to other chapters	37
Dances	37

5. Miscellaneous suggestions.
   - Other subjects suggested (not in questionnaire)
   - Salesmanship—Business for engineers—Mechanical engineering—Extemporaneous talks by members 3 to 5 minutes each—Members to speak at noon lunches
   - Two state that all of these activities are desirable
   - "Meetings should start on time."
   - Trips good if properly organized so all can see and hear
   - Smokers—(several votes).
   - Construction management, estimating and costs.
   - Talks on general economic conditions—analysis of engineering field.
   - Plants manufacturing construction materials.
   - Sports.
   - Bridge whist for those who do not dance

Seattle Chapter now has some idea as to what kind of meetings members want. What kind of meetings does your chapter want?—Professional Engineer.

Surprising Variations in Timber Stresses Allowed by Different Building Codes

Economic Wastes Caused by Present Lack of Uniformity

By RICHARD G. KIMBELL

[illegible] and Building Code [illegible], National Lumber Manufacturers' Association

It is now generally known, as a result of the publicity that has been given to building code provision matters during the past year, that there is a striking lack of uniformity of building regulations in American cities. In view of the fact that the particular divergence that appears most strange is the greatest variation in allowable working stresses for timber, we recommend a study of the data here presented to any and all who take interest in the economical use of lumber in building construction. Since approximately 95 per cent of all homes built are either frame buildings or buildings with frame interiors the strength standards which regulate the size of wood supporting members, and which, therefore, have a direct bearing upon the quantity of materials used in these supporting members, deserve the careful consideration of every one interested in building construction.

Only Eight Per Cent of Cities Specify Timber Stresses.—Investigation shows that 410 of the 1,478 cities with a population of 5,000 or over have a building code, and that only 117, or 28 per cent, of these 410 building codes specify working stresses for structural timber. In other words, practically 92 per cent of the cities with a population of 5,000 or more fail to provide in any way for the economic use of lumber in buildings. Fifty-six of the 117 codes which contain stress tables have no stress values for dense Douglas fir and 98 of these codes contain no stress values for sound Douglas fir. Seventeen of these codes make no provision whatever for dense Southern yellow pine and 58 of them make no stress allowance for so-called sound Southern yellow pine.

There is a similar disregard for varying quality in the stress allowance for other species, and some species are entirely excluded from consideration.

Peculiarities of Codes.—The National Lumber Manufacturers' Association recently made a comparison of the stresses which appear in these 117 building codes which revealed some very strange things. For the sake of having some standard of comparison, the values recommended by the Forest Products Laboratory of the United States Department of Agriculture were taken as a base and in only one code did the stresses correspond with those recommended by that laboratory. While it is true that the stresses in a number of the codes closely approached those recommended by the Forest Products Laboratory, the great majority of the codes specify stresses very much lower. It is hard to account for this. Our guess is that local committees, when engaged in drafting their building regulations, were so confused by the distracting mass of matter that would naturally come to their attention at such a time that they, in sheer desperation, reached out and grabbed any working stress that happened to pass before their vision.

These values might have been hidden away somewhere in ancient treatises on strength of materials or have been stowed away within the confines of one or several of the "handbooks" which have come to be such an institution in America. On the other hand, they may have trustingly copied the specifications from those contained in the code of a neighboring city without questioning the authenticity of those provisions, and their neighbor years before probably proceeded in somewhat similar manner, and so on and so forth until the origin for the timber working stresses became shrouded in the dim and somewhat mythical past.

Stress Allowances.—The wide variation in the extreme fiber stresses in bending is most strikingly indicated in the two following tables:

TABLE I. RANGE OF BENDING STRESSES ALLOWED IN 117 BUILDING CODES

Species of timber	Extreme fiber stress: No. with stresses	No. with no stresses	Range	Horizontal shear stresses: No. with stresses	No. with no stresses	Range
Douglas fir, dense	[illegible]	[illegible]	1800—800	60	57	750—80
Douglas fir, sound	[illegible]	99	1600—1000	18	99	350—80
Hemlock, eastern	[illegible]	[illegible]	1300—600	62	55	250—40
Hemlock, western	[illegible]	87	1500—600	32	85	160—40
Oak	[illegible]	21	1800—600	96	21	240—80
Norway pine	46	71	1250—700	[illegible]	74	150—40
Southern yellow pine:						
Dense*	[illegible]	17	1800—500	101	16	400—70
Sound*	59	58	1500—900	58	[illegible]	350—70
Spruce	[illegible]	[illegible]	1750—250	86	31	500—50
Tamarack	[illegible]	108	1200—900	[illegible]	108	170—[illegible]
White pine	41	76	1500—250	77	40	500—40

TABLE II. RANGE OF COMPRESSION STRESSES ALLOWED IN 117 BUILDING CODES

Species of timber	Parallel to grain, "short columns": No. with stresses	No. with no stresses	Range	Perpendicular to grain: No. with stresses	No. with no stresses	Range
Douglas fir, dense	[illegible]	[illegible]	1600—100	60	57	800—200
Douglas fir, sound	[illegible]	[illegible]	1300—100	18	99	400—200
Hemlock, eastern	[illegible]	57	1200—80	70	47	1000—150
Hemlock, western	32	86	1300—80	26	91	500—150
Oak	[illegible]	18	1500—100	99	18	1000—250
Norway pine	[illegible]	50	1000—100	43	74	400—100
Southern yellow pine:						
Dense*	98	19	1800—820	[illegible]	15	1500—250
Sound*	57	60	1200—750	62	55	800—170
Spruce	83	34	2000—600	88	29	1000—180
Tamarack	9	108	1000—750	9	108	250—220
White pine	41	76	1100—80	80	37	1000—1[illegible]0

*Dense and sound [illegible] No. [illegible] structural, long leaf [illegible] heart, etc., respectively.

Practical Effect of the Variations.—To illustrate the effect that such stress variations have upon the cost of building, and consequently upon the development and commercial growth of a community, suppose we follow through a concrete example of what occurs.

Let us assume that we are supporting a forty-pound live load on timber joists. Let us also assume that the deflection element may be ignored in this particular instance and that the lengths of the supporting members are to be determined by the strength and not by the stiffness of the joists. We will suppose the span length to be 18 ft. This then, is what happens in two cities (City "A" and City "B"), where City "A" in the provisions of their building code, allows a working stress in bending of 1,600 lbs. per square inch, and where City "B" allows a working stress of only 1,000 lbs. per square inch for the same kind and quality of wood.

The enterprising citizen of City "A" who contemplates home ownership, can use wooden joists two inches wide and ten inches deep (2" x 10") spaced sixteen inches apart. His neighbor in City "B," if he uses the same size joist, must space those joists ten inches apart and use over one-third more material than he would be required to use if he built in City "A," or he may space his joists sixteen inches apart, just as his friend in City "A" did, but if he does that he will have to use joists three inches wide and ten inches deep (3" x 10") or two inches wide and fourteen inches deep (2" x 14").

If the latter he would use 40 per cent more material than was required to support the same load in City "A," and if the former 50 per cent more material would have to be used.

Necessity for Quality Specifications.—The stresses appearing in our building codes are based upon inadequate quality specifications, some codes making no pretense to a quality specification except to set down a few indefinite defect restrictions to be administered by the enforcing officer. The enforcing officer must decide if the materials used are suitable, basing his decision on his individual judgment rather than on scientific requirements. He must have some definite standard in the code on which to base his decisions, otherwise they will not stand before a court in case of litigation. High grade lumber is penalized by such procedure and some of the lower grades of lumber which are entirely suitable for use in building construction are not allowed, not because these lower grades will not carry the low stresses which predominate in our building codes, but because the quality specifications keep them out. The working stresses of any structural material presuppose definite quality characteristics. The quality characteristics of structural timber vary with the nature of the product, but we know what this lumber of varying quality will do. So it seems that the most logical thing for our codes to do is to recognize this variation and provide a range of stresses for each species, sufficiently broad to do full justice to the best grade of material and at the same time recognize the use of lower quality lumber. Stresses properly supported with quality specifications will guarantee this result, a result important not only to the manufacturer of lumber, but to the user as well, for it would permit him to use cheaper lumber for certain purposes where it can be just as properly used as the better class of lumber which his city regulations require him to use now. On the other hand, he could use better quality lumber more efficiently than he can under the present system of low stress values.

It frequently happens that the widely known table of stresses recommended by the American Railway Engineering Association is taken bodily and incorporated in a building code without making use of a very important footnote which reads as follows:

"For buildings, and similar structures, in which the timber is protected from the weather and practically free from impact, the unit stresses may be increased fifty (50) per cent."

This table as it stands contains stress values recommended for the design of bridges and other structures where timber is exposed to the weather, and unless the stresses are increased as provided for in the footnote, the values are entirely out of line for use in building design.

Some Lessons from the Burlington Building Fire

The April issue of "Laboratories' Data," a publication of the National Board of Fire Underwriters, contains the following statement relative to the fire which gutted the upper stories of the Burlington Building in Chicago recently:

"There were two enclosed stairways in the Burlington Building. Both had doors with wired glass panels and both had transoms with lights of wired glass at each floor above the ground floor. The wire glass softened and partly fell out in many instances, but in no case was there material fire damage within the shafts. An officer of the Fire Department made several trips up and down the main or central shaft while the fire was raging on the several upper floors. Rule 13b of the Regulations of the National Board of Fire Underwriters for the Installation of Standpipe and Hose Systems (Edition of 1917) specifies 'A standpipe for large streams should be located within fireproof stairway enclosures. Where such are available.'

"The standpipes in the Burlington Building were so located as to be inaccessible from the stairways, in fact they were practically in the burning area, on each floor from the moment of ignition. Had National Standard standpipe equipment been available in the central stairway it is very probable that the Fire Department could have confined the fire to the Clinton Street side of the building.

"The fire temperature in the Burlington Building did not exceed an average of 1800° Fahr., if indeed the average temperature reached that point. The ruins suggest a fire of severity not greatly exceeding the conditions obtained in a one-hour test following the standard time temperature curve employed at Underwriters' Laboratories."

Spray Painting

Requirements for Its Successful and Economic Use*

By RAY W. TRIPP

The use of spray painting equipment operated by means of compressed air, although a comparatively new process of applying paints and other protective coatings, has been extended to a great many new fields during the last year or two The most noteworthy are the interior decorating of office buildings, institutions, etc, and the interior as well as exterior work on houses and buildings of all descriptions.

Unusual demands placed on the paint industry during the recent war were really responsible for the further development of the first paint guns or air brushes, as they are sometimes called, which were used on large surfaces, such as ships, war materials, factory interiors, and similar work. Since then, of course, the equipments, operating technic and especially the paint guns have been improved from time to time until today the outfits are perfected, as well as foolproof. At the present moment the most exacting finishing problems are solved through the use of spraying equipment.

Painting with compressed air and a paint gun requires no introduction to the building manager, master painter or general contractor as the practice is now widely extended. In this age of mechanically operated tools all who handle paints, either making, buying or applying, are familiar with the operation of the newest and most radical development in the science of painting—pneumatic spraying equipment, and the immense saving of labor through the use of the paint gun is self-evident.

Observations and experience on many thousands of satisfactory installations have disclosed interesting facts worth noting at this time. The air scheme of painting enables one operator to paint more square feet of surface than six or eight painters using hand brushes, and to secure finished surfaces which are superior to those painted with a brush. Where single coat work is desired a lighter or heavier coating can be obtained than is possible with a hand brush. Inaccessible surfaces that are difficult to reach with a brush are rapidly painted, as the paint gun may be quickly mounted on an all metal sectional extension pole whenever the operator wishes to paint a surface beyond his reach. Ceilings and walls up to about twelve feet in height may be painted without staging and ladder work; the use of scaffolding or staging is reduced at least 50 per cent on any job. Brush marks, skimped places and laps are entirely eliminated and the covering and wearing qualities of materials are increased. All paints are sprayed to equal advantage at the same consistency as for brush work. Material containers are air tight, which prevents the formation of paint skins, and makes it impossible for dirt to become mixed with the paint.

The next point to be considered is the type of equipment required for work such as the building manager has under his control. The standard equipment recommended and used on this work consists of a portable container of 5 or 10 gallon capacity, with control head for regulation of air and paint pressures, this head containing reducing valves, air and paint strainers, pet cocks and indicating gauges, a paint gun of suitable design, with two guns operated from one head, if desired, an all metal sectional extension pole, and air and material hose in lengths to meet all requirements. A portable compressor outfit, either gas engine or electric motor driven, with air storage tank, necessary gauges and safety valves will complete the outfit.

Realizing that there are certain little "touching up jobs" to be done almost daily in every large office building, one of the largest manufacturers of spraying devices has just perfected a smaller outfit for this class of work. This small outfit comprises the following: a paint gun attached to a one-pint aluminum container by means of quick opening adjustable clamps, suitable lengths of air hose and a small portable electrically driven compressor. The compressor is operated by such a small motor that it may be connected to an ordinary lighting socket, making painting problems as simple as cleaning ones are through the use of the vacuum cleaner.

Of course, the larger outfit mentioned above is absolutely necessary wherever large quantities of work are to be done at one time. The ideal installation usually calls for both outfits as the building manager of today has more than one building under his control and painting is a continuous performance from the beginning to the ending of each year.

Catechism for Paint Users.—Anticipating questions which will arise in the reader's mind, these questions and answers have been arranged:

What is the loss of paint, using spray method?

None, if handled according to operating instructions

What is the covering capacity of the spray on large buildings?

Minimum, 4,000 to 5,000 sq. ft. per 8 hour day; miximum, on large surfaces, 10,000 sq. ft. per 8 hour day.

Can sash and small trim be painted by this method and is it advocated?

By using a line board such work may be done, but not to advantage. One man with a gun on the main body of the building will keep two men busy with brushes on the sash and trim.

Can the woodwork in an office be coated?

Yes, by using a line board and masking glass often found in partitions.

How much air pressure is necessary to operate gun at maximum capacity?

For average work, 50 to 55 lbs. pressure.

Can the spray be regulated?

Yes, it is possible to secure a round conical spray or a broad fishtail spray, and thickness of paint film may also be easily regulated.

What is the width of the spray?

It corresponds to an 8 or 10 in. brush when the gun is held 6 in. from surface to be coated.

How is it possible to handle different paints with the same equipment?

By means of different air and material pressure, as well as adjustment of material control on gun.

How are cold water paints, bronze solutions and heavy lead paints kept in suspension?

An air-operated agitating attachment is furnished for this purpose.

Will the spray gun clog?

No, if material is properly strained and the gun cleaned after each day's work.

Is it possible to do outside painting on a windy day?

Yes, by holding the gun somewhat closer to the work.

Is the use of pneumatic painting equipment advocated by paint manufacturers?

Yes, resolutions favoring the use of spray painting machines were adopted by the Paint Manufacturers' Association of the United States and approved by the board of directors of the National Varnish Manufacturers' Association.

Another question often asked is the following:

How has this method been received by the master painter, the manager and the journeyman painter?

The master painter has been impressed with the fact that the spray method of painting practically creates a new field for him, and another excellent reason is that it increases his volume of work, which means greater profits. The manager or owner welcomes the spray method, as it enables him to paint at a resonable price, making his offices and buildings more desirable, whereas if the work had been figured on brush costs, the price would be prohibitive. The journeyman painter favors the equipment because his occupation has been made much less laborious than with brush work.

There is no doubt that many million dollars' worth of building failed to receive the customary coats of paint during the recent era of high prices of materials and labor. Much of this neglected work now demands immediate attention if the property is to be saved. New building, which we are sorely in need of, will soon be demanding its share of protective coatings. The field for this invaluable aid to modern building is surely extensive.

Pneumatic painting equipment has proved its value beyond a doubt and has earned a permanent place in up-to-date business practice. It is one of the most important agencies through which the wise and comprehending employer makes his employe's job a pleasant and healthful one, at the same time securing more and better work.

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*From Building Management.

Unemployment—Normal and Exceptional—Its Extent, Causes and Remedies

The volume of unemployment in normal times is sufficient to warrant concerted effort on the part of economists and business men to remove certain of its causes, according to a report issued Jan. 18 by the National Industrial Conference Board, 10 East 39th street, New York City. This report, entitled "The Unemployment Problem," gives a brief but comprehensive survey of the extent of unemployment during normal periods and during the present business depression, discusses the causes and analyzes the remedies which have been suggested for it. The object of the survey made by the Conference Board is to set forth certain fundamental principles to be taken into account in considering the problem, derived from analysis of the existing data and experience, and from basic economic considerations, in order to furnish a guide by which individual employers, local organizations or official bodies may approach their unemployment problems more successfully.

The report makes a careful distinction between idleness and unemployment, which refer to very different conditions and arise from different causes. Idleness, it says, proceeds from three principal sources: Unwillingness to work on the part of those who are capable of performing work; disability, physical or mental, of otherwise willing workers; and lastly, unemployment of those who are capable and willing to work, but cannot find work because of industrial maladjustments within the plant or industry, or because of general economic conditions at home or abroad. Idleness of the first type, the report says, is not properly a problem of industry, but essentially a concern of society. Idleness due to sickness or disability of any kind is only in part an industrial problem, and is more especially a matter of community concern. The amount of sickness may be lessened by better public health service, clean streets, pure water, clean milk and better housing, all of which are mainly the responsibility of the community; by personal attention to health and living conditions on the part of employees; and by more attention to health service and plant sanitation by the employer.

The causes of unemployment, in the proper sense of the term, fall into two main classes, described in the report as follows:

1. Internal causes arising from conditions within individual manufacturing plants. These embrace:
   a. Personal factors such as strikes and lockouts, and disability;
   b. Impersonal factors relating either to failures of management, resulting in faulty factory organization, to high production costs within the control of management, ineffective sales methods, lack of materials and equipment, high labor turnover, or to failure of employees because of inefficiency, or to the displacement of hand labor by machinery.

In the aggregate these causes produce a more or less continuous percentage of unemployment from month to month and from year to year.

2. External causes due to influences operating outside of the plant. These are:
   a. Of economic origin, resulting from seasonal variations, business depressions, wasteful systems of commodity distribution, deficient labor placement facilities.
   b. Of political origin, due to immigration and tariff policies and international relationships.

Recurrent temporary unemployment arising from conditions within the plant and recurring acute unemployment due to influences outside the plant, are the subjects of principal interest. Causes of temporary acute unemployment such as fires, floods, earthquakes and like emergency conditions cannot be foreseen, [illegible] their effects are usually brief, and they require relief measures which differ in each case.

These various factors, internal or external to the industry or plant, according to the report, produce a situation that is a pressing problem not only in times of industrial depression, but in normal periods as well.

It is estimated that in 1920 the total number of persons engaged in gainful occupations in the United States, was about 41,000,000. Most of the available employment statistics pertain to wage-earners in the groups of manufacturing and mechanical industries, which numbered, in 1920, about 12,800,000. During normal times, it is estimated that about 1,800,000 of these are out of work, since on the average, about 42 days per year, or about 14 per cent of his total working time, is lost by each industrial wage-earner. About seven days of this lost time is due to sickness. Deducting this, the total loss caused by unemployment of the average wage-earner in the United States is about 35 days a year. This does not include loss from part time employment, for which no reliable figures are to be had. The average of 35 days does not apply to every industry, for the workers in many industries are subject to longer periods of unemployment, while in others the average is low. The building trades and the clothing trades show relatively high percentages of unemployment; the printing trades a relatively low percentage. The report states, however, that the unemployment situation at the time of the preparation of the report, was abnormal, due to business depression. It estimates that over one-quarter of the industrial wage-earners were out of work June 1, 1921, representing an estimated total of 3,500,000 persons.

From its survey of the extent of unemployment, the report concludes that

"Unemployment is clearly not an occasional or accidental condition to be met by charitable or philanthropic relief, but a continuing condition, at times becoming acute. Its improvement is, in part, an industrial problem of the first magnitude. It concerns so large a number of industrial workers and is so vital to industry through its effect on the buying power of communities, as well as for many other reasons, that it merits the united efforts of employers, employees and the public toward understanding its causes and devising methods for its reduction."

Outlining remedies that have been suggested and are being used to combat unemployment, the report says that many concerns are inventing means to better arrangements within their plants affecting the cause of unemployment due to personal and impersonal factors within the establishment. Better methods and more thorough organization to reduce friction and develop industrial co-operation between employees and employers are being tested in many industries. From these experiments there may result principles and forms of organization such as works councils, shop committees, etc., which will call out of employers and employees the co-operation necessary in the present system of production. Management should make and is making efforts to bring close co-ordination within plants and industries, between establishments and localities, and within the nation. These efforts aim to provide greater regularity in the supply of raw materials, to standardize products, to co-ordinate the activities of sales and production departments and to reduce labor turnover. It may be extended to encourage diversity of local industries, to centralize local labor markets, to dovetail employment and develop systems of transfer and promotion.

In order that the economic systems among modern people may function with greater steadiness, this process of co-ordination must be extended between nations and apply not only to the productive process, but to the functioning of middlemen, financiers, etc.

In attempting to remedy the causes of unemployment due to influences operating outside the plan, the report points out, there is need for a more adequate system of collecting and disseminating information showing the trend of prices, the actual cost of operation, and revenues from industry. Such a system will afford a reliable basis of comparison within plants at different times and between individual plants in the industry as a whole. The application of such methods to all industries will provide a kind of clinical thermometer of industry, which will afford a more trustworthy guide for judging future needs and prospects in the industrial system. The more the future situation can be anticipated, the report emphasizes, the more will it be possible to establish bases of control over normal production, distribution and consumption and over the fluctuations from prosperity to depression.

Other means of approaching the problem of unemployment arising from external influences include the bringing about of greater co-ordination between transportation and other forms of industry; arrangements to keep up the maximum flow of foreign trade; and means for centralizing the labor market and distributing more efficiently the available labor supply.

Lacking effective preventive measures such as these, the principle of insurance may be applied for protection against the risks of unemployment, but the report says it would be advisable to eliminate the cause of unemployment and reduce the risk to a minimum before attempting to use such a remedy.

The report considers also certain emergency measures which may be used to start the industrial system on the upward road to prosperity, such as part time work for shifts of workers within the plant and the undertaking of construction work and repairs within the plant. Other emergency measures of value are: Reduction in prices of present stock of goods held by middlemen; revival of the building industry; the undertaking of public construction work, etc.

The report emphasizes finally the importance of formulating wise political policies in connection with immigration, fiscal procedure, tariff and international relations, all of which have an important effect upon general employment conditions in industry.

Construction Material Prices in 46 Cities

The following table from the Index of the Associated General Contractors shows the average prices paid by contractors in March, 1922, for various classes of construction materials. The figures from the U. S. Division of Building and Housing of the Bureau of Standards show the prices paid in 46 cities:

CITY	COMMON BRICK 1,000	PORTLAND CEMENT, bbl. Excl. of containers	DIMENSION LUMBER, M. 2x4-16' 91S1E	COMMON BOARDS, M. No.1, 1x6	FLOORING, M. 1x4, 10'-16'	SHINGLES, WOOD, 100 sq.ft. Extra clear, 16" 5 to 2	SHINGLES, COMPO. 100 sq.ft. Crushed slate surfaced	GYPSUM PLASTER BOARD 3/8" 1000 sq.ft.	LIME, HYDRATED Common, ton	BUILDING SAND Cu. yd.	CRUSHED STONE 3/4" cu. yd.	WIRE NAILS Keg	WINDOW GLASS, 50 sq.ft. Single A 10"x12"	HOLLOW TILE 8"x12"x12", each	CAST IRON PIPE, ton 4" S.H. 13 lbs. per ft.	STEEL PIPE 1" Galv. 100 ft.	REINFORCING BARS 3/4" sq. 100 lbs.	STRUCTURAL STEEL Fab. 6" I beam, 100 lbs.	WHITE LEAD Dry, 100 lbs.	ZINC OXIDE, 100 lbs. Amer. process lead free	GYPSUM PLASTER Neat. ton	LINSEED OIL Raw in bbls. gal.	ROOFING SLATE No.1 Ribbon, 100 sq. ft.	TAR PAPER ROOFING, 100 sq.ft. 2 ply 75 lbs per roll	ROBIN SIZED SHEATHING, 500 sq.ft. 3 ply. 30 lbs. per roll
Akron	13.50	2.53	40.00y	40.00	70.00y	6.50r		47.50	17.00	1.65	3.25	3.00	3.60	.12	49.28	8.36	2.75	2.75	12.25	12.00	16.30	.96	11.50		
Albany	13.50	2.10						25.75	15.00					.19							14.60				
Buffalo	17.12	2.36	32.00y	29.50		5.70r		45.00	18.00	1.28	1.62	3.80	3.90	.19	58.80	10.00		2.65			13.50	1.25	8.00	2.00	1.00
Cedar Rapids	14.50	2.26		35.00	86.00y	6.00r	5.75	40.00	16.00	.90	2.05	3.75		.12	53.90	9.61	2.75	4.00	11.10	15.50	14.20	1.01			1.10
Chicago	11.00	1.87	41.00y	36.00					14.70	2.50	2.15														
Cincinnati	16.00	2.37	38.50y	60.00		4.80r	5.75		13.00	1.50	1.65										14.00			2.25	
Cleveland	14.00	2.64		54.00		7.00r		53.00	14.00	2.50	3.50	3.00							12.25			.99		2.50	
Columbia	10.50	2.83	17.00n	20.00	60.00y	4.50c	5.85	32.00	19.00	.95	3.25	3.40	4.09	.14		9.00	3.20	3.50	10.88		16.90	.89	12.00	2.15	1.00
Council Bluffs	17.50	2.40	40.00f	38.00	100.00f	6.50r	8.25			2.43	3.60	5.85					3.05	4.80	11.31		17.50	1.10		2.90	1.50
Dallas	12.00	3.00	30.00y	25.00	48.00y	4.50r	8.00	33.00	14.00	2.50	2.50	5.00		.22			2.55	4.50			14.00	1.25		1.25	2.50
Dayton	17.50	3.32	45.00y			5.40r	6.50	37.50	14.00	1.85	1.85	4.00	5.00	.19	60.00	9.50	3.00	4.00	12.25	12.00		1.20		2.50	1.25
Detroit	16.50	2.85	40.50y		67.50f	4.53r		30.00	15.20	2.50	3.50	3.75	3.60		53.00		2.60	3.50			19.00	.80			
Duluth	17.50	2.40	35.00f	35.00	75.00f	5.50r	6.00	43.00		1.25	2.60		5.00		50.40	9.30		3.25	12.40	15.50	21.50	.99		2.75	1.00
Erie	15.75	3.00	46.00y			5.25r	7.00	50.00	20.00	2.50	3.00	3.00		.18					12.25		24.00	1.10		2.15	.85
Fairmont	21.00	2.30	35.50y	45.00	65.00y	5.00r	7.00	25.05	13.19	3.40	4.50	3.25	4.20	.14	43.00	8.60	2.00	2.85	12.25		14.90	.85	10.25		.85
Fall River	18.50	2.40							18.00	2.00	3.00			.19											
Flint	14.50	2.23	38.00y	53.00	58.00y	6.00r	6.50	33.20	15.00	2.07	2.61	3.75	4.00	.16	39.83	6.50	2.75	3.75	13.50	10.00	15.25	1.00	15.00	2.25	
Grand Forks	15.00	3.00	35.00y	36.00	80.00y				26.80	3.15											24.00	1.50		3.00	1.75
Haverhill	20.00	2.80	60.00y	40.00	59.00y	6.00r	6.00	46.00	20.00	2.50	3.00	4.10	3.50	.26			2.40	4.00			22.00	.90		2.25	1.50
Kansas City, Mo.	16.50	2.70	41.50y	46.00	63.00f	5.00r	5.80	32.50	25.60	2.35	3.00	4.61	4.50	.22			2.90	2.75	12.37		15.50	.71			1.20
Little Rock	12.50	3.70	30.00y	32.00	45.00y	4.75r	6.50	35.00	24.00	1.00	2.00		5.00	.20	65.00	11.00	3.25	3.50	12.00	12.00	25.00	1.10	16.00	2.25	1.25
Lorain	14.00	2.58	45.00y	65.00	70.00y	5.60r			9.50	2.15	2.94	4.00		.12			2.85	2.35							
Louisville	15.00	2.38							24.00	1.30	1.40			.13			2.27								
Milwaukee	12.50	2.40	35.00y	32.00		5.50r	6.50	32.00	20.00	1.50	2.50	3.25		.14			2.25				17.00			2.00	
New London	18.00		50.00y	50.00	85.00y	7.00r		50.00	30.00	1.25	3.50	4.55	5.00	.25			2.95		13.50			1.15			1.75
New Orleans	11.00	2.55	27.00y	30.00		4.50c			14.00	1.50	2.70	3.00		.19			3.50	3.30						2.00	
Niagara Falls	17.50	2.44						25.00	18.00	1.75				.20							16.00			2.00	1.15
Pasadena	17.00	3.30	48.00f	46.00	85.00f	6.50r		44.00	32.00	1.75	3.75	6.01							12.00		20.00	.98		2.55	
Pittsburg	16.00	2.02	47.00f	45.00	78.00y	4.68r			14.30	1.95	2.65	3.10	2.80	.13	47.50	7.06	1.55		12.25	8.00	16.40	.90	11.00	1.90	1.35
Pontiac	14.40	2.19	32.50y	39.00	51.00y	5.75r	5.70	23.93	13.[illegible]0	1.50	1.48	3.75		.17	52.00	8.50	2.40	2.25	12.50		13.90	1.00	17.10	2.75	1.00
Redfield	17.00	2.51	31.00f	31.00	71.00f	4.00r	6.00	28.00	15.80	3.25	6.[illegible]	4.75	5.00	.15			3.50	3.60	13.75		15.90			2.50	.75
Sacramento	17.00	2.79	27.50f	22.00	55.00f	6.25r				1.25	2.25	4.10	5.00				3.90								
Saginaw	12.00	2.10	45.00y	37.50	60.00y	5.00r	6.50	32.00	18.00	2.00	3.00	3.20	5.40	.15	45.00	8.75	2.85	3.00	12.25	16.00	15.00	.85		2.75	
St.Petersburg	18.00	3.60	28.00y	55.00	65.00y					4.50	3.25														
St.Louis	14.00	2.40	39.00y	42.00	62.00y	6.25r	6.38	43.25	20.00	2.80	2.10		4.50				1.88		12.25		19.50	.99			.83
San Antonio	16.00	3.00	45.00y	48.00	75.00y	7.00r	8.00	52.00	22.50	2.75	2.60	4.40	5.40	.21	59.00	9.40	3.75	3.80	13.75	23.00	24.00	.97		2.58	1.80
San Francisco	15.50	2.55	30.00f	28.00	65.00f	5.00r		40.00	22.00	1.50	2.50	4.00	4.50	.18	44.60	8.40	2.75	3.65	11.75	17.00	14.80	1.05			2.00
Seattle	13.00	3.35	15.00f	15.00	55.00f	2.80r		42.50	24.00	2.00		4.25		.25	50.00	10.25	3.25	5.00	11.75	18.00	19.00	1.05	30.00	2.50	1.20
Shreveport	15.00	3.80	41.00y	43.00	82.00y	7.00r	8.00	34.00	27.50	2.00	5.00	4.80	4.50	.19	77.00	9.40	3.60	4.00	12.00	23.00	24.00	1.00	12.00	2.25	1.25
Sioux Falls	18.00	2.60	37.00f	35.00	84.00y	4.60r	7.50	32.00	22.50												18.00			3.00	1.15
Syracuse	18.00	3.00	38.00y	35.00		4.50r	6.00	45.00	24.00	2.00	2.90	3.75	4.00	.25	47.50	11.00	3.00	2.90	12.25	19.00	16.25	1.10	11.00	2.00	1.75
Tampa	12.45	3.30	27.00y	36.00		4.90c	7.50	40.00	14.80	1.65	4.50	4.25		.18		10.50	2.50	3.50	12.25	16.00	22.50	.90	19.00	2.50	1.25
Toledo	15.00	2.20	41.00y	60.00	75.00y	5.60r	6.30	34.00	13.20	2.22	2.19	3.55		.15							14.50	1.10			
Warren	15.90	2.36	48.00y	45.00	65.00y	5.60r	7.50	45.00	13.10	2.16											15.50				
Waterloo	14.90	2.33	40.00y	36.00	94.00y	7.00r	8.00	25.00	20.00	1.50	3.00	4.70	7.00	.12	45.00	9.50	2.10	3.20	12.00	15.00	13.60	.81	20.00	2.45	1.47
Youngstown	18.00	2.60	50.00y	45.00	80.00y	7.00r	7.50	35.00	20.00	3.37	2.50	3.25		.15	61.60	11.00		3.50	12.25	12.25	14.00	1.20			

*F.O.B.Job; c.Cyprus; r.Red cedar; n.North Carolina pine; f.Douglas fir; y.Yellow pine.
Note-Yellow pine flooring is B.G.C., Douglas fir flooring is V.G.No.2.

Junior Engineer Examination

The United States Civil Service Commission announces competitive examinations for the position of junior engineer, to be given on May 24, July 5 and Aug. 23 at various places in all the states. Salaries range from $1,200 to $1,500 per year, except under special circumstances, when they may be either higher or lower.

The subjects of the examination are: General physics; mathematics, through calculus; education, training and experience; practical questions on one of the following optional subjects: electrical engineering, mechanical engineering, civil engineering, chemical engineering, ceramic engineering, radio engineering, engineering and materials. Full information will be furnished by the Civil Service Commission upon request.

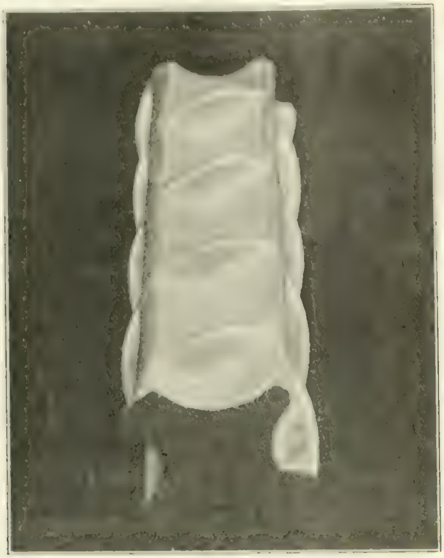
Heating and Ventilating Engineers to Meet

The American Society of Heating and Ventilating Engineers will hold its national convention at Detroit on June 8, 9 and 10. Headquarters will be at Hotel Wolverine. A preliminary, or "First Section" of the summer meeting will be held at Buffalo on June 6 and 7. Arrangements providing for those in attendance to leave for Detroit by boat at 6 p. m., June 7.

Lumber Treatment in 1921.—Over 2,400,000,000 board feet of timber for various purposes were pressure treated in 1921 by the 122 wood preserving plants in operation throughout the United States, thereby surpassing the 1920 record by nearly 17 per cent. Approximately equal amounts were treated with coal-tar creosote and with zinc chloride, the standard wood preservatives.

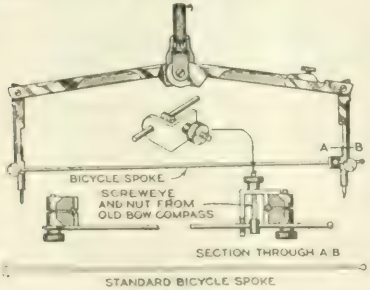
A New Reinforcing Bar

The deformed bar, a short section of which is illustrated herewith, is the recent invention of Mr. [illegible] Royse. Among the various advantages claimed for this bar, the first is that the metal is distributed as far as possible from the neutral axis. Other advantages are that it is entirely free from sharp corners, all faces being either concave or convex; that it provides a maximum of bond for a given weight of metal; that its design prevents the formation of air pockets against it; and that it is adapted to any class of work in which loose rod systems are used.



A Simple Compass Stiffener

Every draftsman knows how hard it is to use a compass in the manner shown, without its spreading and altering the adjustment so that the circle or arc being drawn will not be of the radius to which it was set. The drawing shows an easily made clamp and stiffening bar that can be used on the compass to hold it firmly in the position to which it is extended. A bicycle spoke is flattened slightly at one end and a hook is formed to fit around the screw as shown. A small U-shaped clamp and the screw eye and nut from an old bow compass are used to complete the attachment. A hole is drilled in one angle of the clamp, through which the bicycle spoke passes, and another hole is drilled in the other side for the accommodation of the screw eye and nut. The compass is not altered in any way, and the brace and clamp are applied to it as shown, with the hook applied over one of the binding screws, the bicycle spoke bearing against one side of the compass leg and the clamp against the opposite side.—Clare B. Smith, Chicago, Ill., in Popular Mechanics.



Details of Stiffener

The New American Architecture. Simplicity and truth are two outstanding features in the national type of American architecture which is noticeably developing under the urge of commercial and civic growth. There is little ornament and not much attention to the ornate in this type of building. These modern American structures are just what they seem to be. They are imposing and impressive.—The Architect and Engineer.

Personals

W. C. Earle, formerly of San Diego, has been appointed city engineer and superintendent of streets of Pasadena, Calif.

R. G. Humphreys has joined the staff of J. F. Nebergall & Son and is now superintending building construction in Davenport, Ia.

A. H. Monroe, assistant city engineer of San Diego, Calif., has resigned that position and accepted an offer from the City of Los Angeles.

John A. Vogelson, since [illegible] chief of the Bureau of Health of Philadelphia, became chief of the Bureau of Surveys in the same city on March 15.

Charles Evan Fowler, consulting engineer of New York and Detroit, was made an honorary member of Gamma Chapter of Tau Beta Pi at the University of Michigan on May 6, 1922.

John H. Mahony, long supervisor of construction for the Building Department of the City of Boston at $3,000 per year, has been named building commissioner at a salary of $6,000 per year.

J. A. Mortland, for the past five years bridge engineer with the Florida State Road Department, has resigned his position, effective May 1. He will open an office as consulting engineer in the state. His plans are not yet complete.

The Benham Engineering Co. of Kansas City has been retained by the City Council of [illegible], Mo., to investigate and report on sewage disposal plants, which have been the source of much complaint, and which it is intended to correct.

John G. Hirsch, formerly supervising engineer for Lockwood, Greene & Co., engineers, Chicago, and Stone & Webster, Boston, has become associated with the Benham Engineering Co., consulting engineers, Kansas City, Mo., as principal assistant engineer.

Carl G. Schluederberg of the Westinghouse Electric & Manufacturing Co. has just been elected president of the American Electro-Chemical Society, the election having taken place while he was en route to the United States from South America, where he made a survey of business conditions.

Archibald S. Downey was elected president of the Northwest Chapter of the Associated General Contractors of America at the convention held in Portland, Ore., on March 10-11. Mr. Downey has been located in Seattle, Wash., since 1899, and since 1909 he has been a partner in the firm of A. W. Quist & Co., with offices in the Hoge building.

Clarence W. Hudson, consulting engineer of Montclair, N. J., has been selected by the New Jersey State Highway Commission as consulting and designing engineer for the proposed Raritan River bridge between Perth Amboy and South Amboy. It is estimated the span will cost more than $4,000,000. The engineer's fee will be 6 per cent of the contract price.

Prof. Harry Sternfeld, acting head of the Department of Architecture, Carnegie Institute of Technology, Pittsburgh, recently received a medal and diploma awarded by the Pan-American Congress of Architects that met in Montevideo, Uruguay. The award was made in recognition of work done by Mr. Sternfeld in the field of architecture.

James Chillman, Jr., has been appointed assistant professor of architectural design at Carnegie Institute of Technology, Pittsburgh. Mr. Chillman for the past three years has been studying at the American Academy at Rome as the holder of the Roman Prize Fellowship. He is a graduate of the University of Pennsylvania, in the class of [illegible]. For some time he was an instructor at the University of Pennsylvania and for several years was instructor in architecture at the Rice Institute, Houston, Tex.

Henry Sylvester Jacoby, professor of bridge engineering at Cornell University for more than thirty years, is to retire from active teaching in June and to become professor emeritus. Though best known through his text books and other technical writing, Prof. Jacoby is by no means exclusively an office engineer. During the first nine years following his graduation from Lehigh University in 1877, he was engaged on surveys in Pennsylvania, Louisiana and Tennessee in various capacities under the Corps of Engineers of the United States Army. Following this he served for about four years as instructor at Lehigh University immediately prior to joining the Cornell faculty. Prof. Jacoby's retirement is greatly lamented by the engineering students at Cornell, and particularly by those upper classmen who have been working directly under him.

Obituaries

William C. Foote, pioneer contractor and builder of Provo, Utah, died May 11 after a long illness.

Nat A. Kent, vice president of the Kenwood Gravel Co., of New Orleans, died on April [illegible] as the result of an accident in the discharge of his duty.

Frederick D. Dow, president of the Dow Company, Inc., roofing contractors and paint manufacturers, was found dead in his home in Albany, N. Y., on May [illegible].

P. M. Connolly, city engineer of [illegible], Wis., died May [illegible] after a week's illness. He was a graduate of the state university and well known in municipal circles.

John Cochrane, well known building contractor of Madison and Indianapolis, Ind., died in Indianapolis on May 18 at the age of [illegible]. Mr. Cochrane built many of the churches, schools and other public buildings which were erected in or near Madison prior to 1885.

George Marion Howe, one of the leading metallurgists in the United States and for many years professor of metallurgy at Columbia, died on May 11 at his home in Bedford Hills, N. J. Mr. Howe was a past president of the American Institute of Mining Engineers and was well known for his numerous technical writings as well as for his other work.

John Volk, contractor and builder in Rock Island, Ill., for fifty-seven years, died at his home in Rock Island on May 9. Mr. Volk was the founder, in [illegible], of John Volk & Co., a concern which did extensive building for the Chicago, Rock Island & Pacific Ry., erecting more than 100 stations for that road. Mr. Volk and his company did much other work in various parts of the Middle West.

Foreign Engineering Review Quarterly Issue

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Roads and Streets—1st Wednesday
(a) Roads
(b) Quarries and Pits
(c) Streets
(d) Street Cleaning

Waterworks and Hydraulics—2nd Wednesday
(a) Water Works
(b) Irrigation and Drainage
(c) Sewers and Sanitation
(d) Waterways
(e) Quarries and Pits for Ballast and Concrete

Railways—3rd Wednesday
(a) Steam Railway Construction and Maintenance
(b) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures

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Political Interference with New South Wales Railways

Editorial in The Commonwealth Engineer, Sidney, New South Wales, April 1, 1922

Pandering to the demands of labor and other brands of extremists, the N. S. W. premier, Mr. J. Dooley, during the course of the state election campaign, announced that the policy of the labor party, if returned to parliament with a majority, would be to replace the present railway commissioners by the appointment of other commissioners, including a direct representative elected by the employees. The intention was also announced of amending present legislation in the direction of giving the government more authority in the administration of the state railways and tramways. One of the chief reasons given for the contemplated change in personnel of the commission is that business men are required to place the state railway system in a position to reduce fares and freights, also that the cabinet should have power in the direction of vetoing any contemplated increases. The muddled reasoning which inspired these crude ideas is apparent when it is remembered how this same government recently put through parliament a 44 hours' act, which applied to the state railways as well as other industries, an act which at once increased operating costs without any tangible return. In another column we publish a summary of an independent auditors' report just published, reviewing the financial results of the state railways system. Apart from the fact that this does not disclose any want of commercial acumen on the part of the present commissioners, it shows that high wages and short hours govern the ruling charges, and if they are unduly high the commissioners cannot be held blameworthy. In this connection, the present average weekly wage in the service, namely, £4/18/6 per week, is higher than that prevailing in any of the other states, whilst the average number of hours work per week, 43.83, is the lowest. In spite of these factors, however, the system was shown to compare favorably in the matter of charges with those of other countries. There is no proof, therefore, that the proposed alterations in the commission would allow of cheaper fares and freights; on the other hand, there would, more likely, be higher charges, or more taxation on the taxpayers. It is interesting to record that the chief commissioner, who by his duly constituted position, exerts a controlling influence on the commission, is an engineer of high qualification and railway experience, whilst the third member was at one a time a politician, a member of a former labor movement, whose appointment at the time was sought to be justified on the grounds that harmonious relations with the rank and file of the staff would be strengthened. That this latter claim had no justification was demonstrated by the subsequent strike in 1917. This should indicate the futility of another similar appointment, for the same ostensible purpose. Only last month the government, whilst a general elec-

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With any of these annoyances by which you may have been affected we ask you to be patient; but at the same time kindly to inform us of any errors which you wish rectified or of any continuance of such errors.

ENGINEERING AND CONTRACTING.

tion was in progress, went out of its way to make one of these political appointments, by elevating to the harbor trust commission a gentleman whose main claim to preference, apart from being a political labor supporter, was that he was secretary to the coal lumpers' union! The new appointments contemplated can only spell the application of political rule to the railways, when the sole object of those so appointed would be to cater to the demands not of the community, the employer, but of the agitator and union demagogue. Also as one with extreme views would in all probability get the nomination of the unions to the coveted position, the inevitable clash with colleagues trained as engineers or in railway finance and traffic management, would surpass Gilbert and Sullivan. The serious and regrettable aspect of such a proposal is the mentality which is evinced by the suggestion alone, and it is to be hoped that events will prevent the carrying out of such a policy. The plain fact remains that the efficient control and administration of railway systems and harbor trust undertakings, require that those who are responsible should be engineers of sound training and extensive experience, with colleagues whose financial and administrative experience is beyond question. The so-called harmonious relations with the staff do not constitute a problem that necessitates the appointment of a commissioner for this special purpose. Such relations are bound up with conditions of work and rates of pay, which are matters decided by wages boards and arbitration courts. A keener appreciation of the important place the engineer occupies in the requirements of the country, one expects even politicians to recognize, otherwise such proposals to which we direct attention can only be described as "political sop" to sections of the electors.

The Government and Inventors

Editorial in Engineering, London

That a shoemaker's children are aye illshod is a familiar proverb, and thus it is perhaps not a matter for surprise that the report of the interdepartmental committee appointed to consider the question of awards to inventors, in Government service, shows a singular lack of scientific method. The committee apparently set themselves to collect opinions and not to ascertain facts. In Germany, in America and at Sheffield, manufacturers have established and operated research departments, with striking success. A committee which believed in scientific procedure, would assuredly have deemed it a matter of first importance to ascertain what methods of remunerating the workers had been found advisable in these cases. No trace of such an investigation is to be found in the report, and the committee evidently share the predilection of the politician and lawyer for deductions based on plausible a priori hypotheses. Inventors in Government service fall into two classes. In certain cases men are appointed to investigate a definite problem, and given adequate equipment and fair intelligence, they can hardly fail to arrive at valuable results. A typical example is afforded by the study of alloys carried out at the National Physical Laboratory. In such circumstances there is nothing inequitable in the view that the investigator has no property rights in his discoveries, which may quite fairly be vested in whoever has provided the means by which he achieved them. Similarly, if Hughes had [illegible] to patent the microphone, and to [illegible], he would obviously have been fairly entitled to the improvements effected by the staff engaged for this latter purpose.

Other questions than those of mere equity are, however, involved, and it may quite possibly be profitable to grant to those engaged in such work more than their legal rights. It is on such matters as this that the committee should have sought guidance from the experience of firms who have successfully organized research establishments. Almost the only statement of fact made in the report is that the Government departments exclusive of the Post Office have generally reserved to themselves all rights in inventions and discoveries made by members of their staffs. The inventions thus claimed, it will be seen, include those not discovered in researches "made to order," where as stated there is nothing inherently inequitable in the contention that the investigators' remuneration is fully covered by their salary. The committee, however, go much further and say that if men not specifically engaged on research make inventions, "if these arise either in the course of their employment or with the aid of knowledge" thus gained, "obviously the Government has certain rights in the invention." Unfortunately the justice of this contention is very far from "obvious," as is very clearly seen from the following case which actually occurred. Many years ago a driver employed by a leading firm of steam roller builders devised a road scarifier. His employers told him to go ahead and patent it and they would make it under license. First and last they paid out to him and his heirs over £20,000. Now undoubtedly in this instance, the idea of a scarifier would never have occurred to this inventor save for the knowledge and experience he had gained in the course of his employment, but it is by no means "obvious" that this circumstance gave his employers either a moral or a legal right to the invention. In another case a civil engineering assistant employed by a large waterworks company devised a new form of borehole pump. Here, again, the pump was the direct outcome of knowledge gained in the inventor's employment, but the waterworks company made no claim to the invention, and, moreover, when the chief engineer proposed to use the pump on condition that his assistant forewent his royalties, the directors cancelled this condition and thought it fair that they should pay the ordinary market price for the improvement. We are well aware that certain firms follow a different policy to that illustrated in the above examples, but it is to be doubted whether they really benefit by it. Carnegie treated his technical staff as partners, and asserted that he found the procedure highly profitable.

As mentioned in the report, the contrary policy has been pursued generally by Government departments in the past, and with unconscious humor the committee observe that the actual number of men who made inventions in Government service has been comparatively small. They do not, however, seem to see any connection between this unfortunate fact and the departmental regulations, which in their essentials are to be retained and extended. The only concession made is the appointment of a special committee to adjudicate on the respective claims of an inventor and the department which employs him. The onus of proof is in all cases to rest on the applicant, the assumption being in every case, until the contrary is proved, that he has no title to his discovery or invention. It is most improbable that this slight concession will effect any material improvement in the present state of affairs. One would have expected the Committee to comment on the circumstance that since the telegraphs were taken over by the Post Office practically every important improvement has been imported from abroad, whilst previously this country played a major part in the betterment of methods of telegraphy as it has continued to do in the cable services. The committee, in short, seem to have considered as outside the scope of their reference, any inquiry into possible methods of fostering discovery and invention in departmental services. Anyone who has been even remotely connected with those responsible for really important pioneering work, will realize that this will never be undertaken for a mere salary. The nervous strain, involved in practicalizing such improvements, is too intense, to be faced without at least the hope of some substantial reward. The gap between a really novel laboratory discovery or a really original ingenious idea, and its development into a commercial success involves commonly months or years of patient industry, as well as the assumption of heavy pecuniary risks. Of course, in general, we do not expect work of fundamental importance from research departments, whether financed by the Government or by private firms. Our Faradays and Kelvins would be out of place in the National Physical Laboratory, whose true function is to help industry by establishing standards and acquiring accurate experimental data. Pioneering work should be discouraged here, its true home being the laboratories of our Universities or the workshops of private investigators. Nevertheless, although investigations of this kind are neither to be expected nor desired in departmental research establishments, civil servants have been responsible for some highly important discoveries. Unless our memory is at fault, both Henry Cort and Sydney Gilchrist were in Government employ when they worked out their epoch-making improvements in metallurgy. They were not engaged as technical experts, but according to the recommendations of the committee, the departments by which they were employed would have had a prima facie claim to their discoveries, and they would be required to establish the contrary before a committee of investigation. Such a procedure, however liberally worked, will tend to check invention and discovery, which is the reverse of desirable.

The committee do not appear to be consistent in their recommendations. They observe that in certain cases research workers are engaged for only a part of their time and for a specific purpose. If one such makes an invention unrelated to this special work the committee admit that this should vest in him only. Apparently, however, a full time worker is looked upon as belonging body and soul to his department, and should he make an invention not connected with his official duties, this is apparently to be treated on a different basis.

The committee seem to think it possible and desirable, though difficult for the Government to exploit commercially valuable inventions, and they assert that there is a probability of an increased industrial use of inventions made primarily for Government purposes. It would be well if the committee had given instances of such, as it is difficult to understand without illustrative examples the kind of work the committee have in view. A possible instance is the "leader gear," but we imagine it would be better for the public were the exploitation of this to be free from payment of royalties. Another possible instance is that of useful alloys, and here again it would probably be in the public interests that such results of departmental research should be freely open to all. On the other hand, certain results will assuredly be attained in the laboratory which can only be made commercially available by a large expenditure of time and capital in the work of practicalization. This work will certainly not be undertaken unless those responsible for it are granted a monopoly for a term of years.

The committee state that several witnesses affirmed that there had been cases in which the credit and benefits accruing from an invention have been filched by the official superiors of the true and original inventor. In view of what has happened in other departments of Government nothing is more probable. The credit of the best work of the experts on geodesy employed on the ordnance survey has frequently been assigned to the official head of the department, who merely signed the reports.

Steel as an Architectural Material

Editorial in The Engineering Review, London.

One of the difficulties with which structural steelwork has had to contend in the past in attaining its legitimate position for buildings other than workshops, has been that architects are trained principally from the artistic and historical standpoint and that they have regarded steelwork as inherently ugly.

This difficulty is a strange one from one standpoint, because in a steel frame building the steelwork can be completely hidden and the external walls, which function only as fillings between the openings of the steelwork, can receive architectural treatment to follow any style or order desired. If architects are willing to take structural engineers into their counsels early in the development of the plans of a building much economy of materials can be effected and many vexatious altercations of plans avoided, and it is hoped that the younger generation of architects is being trained with due regard to the legitimate function of steelwork in construction, and that they will not adhere to older methods because they understand them better. The architect has to cover a very wide range of activities, in all of which it is humanly impossible for him to be a specialist, and I cannot see that he should regard it as derogatory to his professional standing for him to refer matters relating to steel construction to engineers who have specialized upon that class of work and who are familiar with its technical intricacies.

But a new school is arising among architects which objects to the hiding of the members upon which the building relies for its strength, and is opposed to "sham" wherever it can be avoided. It is from this school of architects that we may hope for much future progress in steel construction. As engineers we have always denied that steel structures are inherently ugly; in fact, we believe that there is close correlation between efficiency and beauty. We believe that the architects can, and ultimately will, succeed in designing buildings with exposed steelwork that will give the necessary artistic effect for which the architects are legitimately striving; but the dictum as to the undesirability of putting new wine in old bottles applies here as in many other matters, and it will be necessary to cast right aside ideas of architectural form which were based upon stone block construction.

Stresses, Calculable and Incalculable

Editorial in The Engineer, London, May 5, 1922

Although the scientific engineer rightly relies to a very large extent upon the calculated values of stresses in the working parts of his machines and structures, practical experience, as well as a closer theoretical consideration of the question alike go to show that at times materials are exposed to very much more intense loading than that which had been anticipated from ordinary data and calculations. The mere fact that failures sometimes occur in parts where no defective material can be traced and where the calculated working stress was far below even the specified yield point of the material, serves to establish the occurrence of such cases. Fortunately, however, actual failures from such causes are very rare and represent only a small fraction of those cases in which the actual working stresses are very considerably greater than those indicated by calculation. Now we do not desire, by raising this point, to throw any doubt upon the fundamental value of stress calculation. On the contrary, we would insist rather upon the importance of so improving our methods of calculation that such cases may be increasingly eliminated. At present the uncertainty which exists under this head is one of the factors which remains to be covered by the "factor of safety," but it is fully recognized that engineering progress, particularly where requirements regarding weight are stringent, often implies an enforced cutting down of these wide margins and, therefore, a fuller utilization of the strength of the materials employed. Elimination of uncertainty as to the actual stresses involved must therefore also be eliminated to an increasing extent.

At first sight this would seem to be little more than a plea for the fuller development of the mathematical side of the theory of structures and materials, but while such a development is required, we would draw particular attention to another aspect of the matter. It relates to the closer study of the materials upon which the stresses have to act and of their behavior. The mathematical basis of calculations always requires the material to be uniform and isotropic—i. e., that it should have not only the same length, but also the same elastic properties in all directions. Actually, in the case of timber, it has been found that this property is lacking, while there is room for doubt even in the case of metals. As regards strength, at all events, longitudinal and transverse properties differ very widely in rolled and drawn materials. The whole problem is, however, affected to a very much greater degree by an entirely different factor. This factor is the existence in many materials of important internal stresses, i. e., of stresses which exist in the material in the entire absence of external load. Such internal stresses arise when a piece of metal has undergone changes of shape or volume which are not uniform throughout its mass. For instance, when a rod or tube is subjected to cold drawing, the outer skin is extended to a slightly greater degree than the inner portions. At the end of the operation the material is left in a stressed condition, with the "extended" skin under elastic compression and the remainder in tension, both stresses being such that they suffice to equalize the dimensions of the two portions of material. The presence of such internal stresses is readily ascertainable by cutting up the metal in a suitable manner. If, for instance, in the case referred to, the outer compressed skin is cut through so as to leave it free to contract, the total dimensions of the tube are diminshed by a slight amount. Stresses can be detected in this manner, which, on calculataion, indicate that the material was internally or "self-stressed" to a point not very far below its normal breaking stress. The point which we wish to emphasize, however, is that if external loading is applied to material in such a condition, where the internal stress has the same sign as the applied stress, the two add up and fracture, or dangerous nearness to fracture, may result at a point where the calculated working stress is quite moderate. Now the presence of such internal stresses in cold-drawn or otherwise cold-worked metal is well recognized and constitutes one of the reasons why, for many important purposes cold-worked material is regarded with justified suspicion by designers and users. The very great convenience of such material, however, presents a temptation towards its use which is not always resisted. Fortunately, it has recently been established, principally by Dr. Moore and his collaborators at Woolwich, that by heating cold-worked brass, for example, to quite a low temperature (about 300 deg. Cent.) for a short time, the internal stresses can be very largely removed without appreciably weakening or otherwise altering the properties of the material, and doubtless similar treatment is possible with other alloys and with steel. If it were universally applied much of the present mistrust of cold-worked metal might be overcome. There are, however, other sources of internal stress in metals besides the cold-working operations usually so-called. These causes are in reality more dangerous than the others, since the presence of serious internal stress is not always recognized. One group of such causes arises from heat treatment involving rapid cooling or quenching. The hardening of steel, even if of a relatively mild nature, involves changes of volume, and these changes do not occur at the same time and to the same extent throughout the mass. The resulting differences of dimensions thus have to be equalized by elastic strains, and in some cases actual rupture results in the formation of the familiar hardening cracks. In other cases the material remains intact, but severely stressed internally. Subsequent tempering, provided that it is sufficiently drastic, no doubt serves largely to wipe out these heavy internal stresses, but important residual stresses frequently remain. In certain alloy steels, for instance, the tempering itself must be followed, if "temper brittleness" is to be avoided, by a second quenching or rapid cooling, and although this is not so severe as true hardening quenching, it may yet cause cracking or set up important internal stress. Another form of "heat treatment" which may, and sometimes does, cause serious internal stresses is the process of autogenous welding, whether by the electric arc or the acetylene flame. Local heating inevitably causes differential expansions and subsequent contractions, and the possibly heavy resultant stresses should be fully considered in connection with the loading of parts which have been treated in this way.

Heat treatment is not, however, the only source of internal stresses, mechanical deformation applied in the cold during manufacture or construction being a still more serious cause. Whenever a piece of metal is bent cold, although apparently entirely uninjured and possibly even hardened by the operation, it is inevitably left with a certain measure of internal stress. In the simple bending of a strip of plate the portions near the neutral axis are stressed only within their range of elastic recovery, while the outer portions undergo permanent plastic extension or compression. When the external bending force is removed the inner elastically strained portions tend to re-straighten the piece, but are resisted by the permanently deformed outer portions; a system of counterbalancing internal stresses is thus set up. A still more striking case arises from such operations as riveting. Quite apart from such manipulations as forcing holes to meet when the fit is not quite perfect, and similar forcible proceedings, the closing of the rivets and their subsequent contraction during cooling, imposes very high and localized stresses upon the rivets and plates. These forces come upon the material precisely at those points where working stresses are highest and, in unfavorable circumstances, failure may result, perhaps only after the lapse of many years. These considerations need not and, of course, will not alarm us in any case. In the vast majority of cases our structures are amply strong enough to resist these internal stresses when added to the following working stresses, but they should be taken into account where they exist and their existence should be avoided wherever possible.

Measuring Locomotive Wheel Loads. A locomotive weighing machine for ascertaining the weight resting on each wheel and thus enabling the springs to be properly adjusted, which Messrs. Henry Pooley and Son, of Birmingham, are now making to the order of Sir William Arrol and Co. for the Enugu workshops of the Nigerian Railways, has 14 tables, each 4 ft. 6 in. long, and with a capacity of 8 tons. The tables are on the three-lever principle arranged to prevent tipping when the locomotive bears upon the extreme edge in passing upon or leaving them.—London Times Engineering Supplement.

Labor Unionism in Australia

Editorial in The Commonwealth Engineer, Sydney, New South Wales, April 1, 1922.

Whenever our country is visited by independent and studious observers, who are not afraid to tell us what they think, we hear that our towns and cities are under-industrialised, and that our country districts are under-cultivated. In short, we are not producing enough. Is it that we have not sufficient men to work in our factories or to cultivate our lands, or is it that our capitalists are content to sit down with their money invested in gilt-edged securities? One section of our community will say that we have enough men to do the work, provided they get sufficient pay and have not to work very hard; another section will say that we have not enough men to do all the work there is to be done if that work were done efficiently, and at a fair remuneration, so that we can compete with other countries. Omitting any reference to agricultural pursuits, which obviously have not attracted the numbers that this country calls for, and referring mainly to our urban industries, it is very noticeable that the desire of our industrial chiefs to expand and produce is thwarted by the determination of a minority with temporarily exalted powers, who declare that we have enough men in Australia to man our industries. They rather try to enforce the employer, firstly, to pay a rate of wage out of proportion to the work done; and, secondly, to agree that these men are overworked, and that they should work shorter hours.

A noted case where it was thought there were enough workers in the Commonwealth occurred when some seamen on a British ship, who were not members of the Australian seamen's union, were not allowed to work on this ship, or to join the Australian branch of their own union so that they could work on our coastal ships. These men, not being able to work at the calling most suitable to them, had to be repatriated as distressed British seamen. In the matter of skilled labor a curious anomaly exists. In many industries where work is done by tools and machinery, guided by the sober use of intelligence, it has been found to work in the best interests of all concerned, to apprentice young men to some special work, and to let them improve their status by their own diligence. These apprentices were encouraged, and the trade attracted many youths. These youths, moreover, were given the opportunity of attending night classes at technical schools, and could thus obtain an outlook different and higher than the mere automaton, to whom education does not appeal. Many of these apprentices grew up in their trades and became skilled workers. Others probably were not so skilled. Their leaders, however, say to them "if you limit the number of apprentices, you will always be sure of your job"; hence the absurd state of affairs reigns in which apprentices are so limited in numbers in the various trades that there is not a sufficient number of young men being trained to meet the normal demands of industry. Moreover the majority of them do not exhibit much desire to obtain educational advantages, neither do they display that keen spirit of rivalry which tends to produce the efficient tradesman. To some this might seem the utopia of the working man; but unfortunately we are up against the competition of other countries who know the advantages of hard work and efficient preparation in the training of the tyro in his trade. These countries are not naturally endowed to the extent that Australia is, and it frequently happens that efficient craftsmen, who have gained their knowledge in rigorous and competitive apprenticeships, desire to come to live in Australia. It is found that these men (many of whom are trained mechanics) are better by far than our own men, through the efficient training of a thorough apprenticeship. It has happened recently and complaints have been made by union leaders that preference is given to these men. But it was pointed out in this specific case that 80 per cent of the unionists were immigrants, and that a clause in a recent award made it necessary to give preference to unionists. Are members of the engineers' and blacksmiths' unions going to act like the seamen and refuse to allow any mechanic immigrant to join the union so that the present members can retain their jobs? It is time that the workers recognized that they, and all, are specially favored in this country, and that they should become imbued with that spirit of emulation which would make the Australian tradesman as efficient as any in the world, and which would tend to a greater production at reduced cost.

Concrete Truss Girder in New Street Viaduct at Dover

Details of Design and Severe Tests on Finished Structure

From Engineering, London, March 3, 1922

Those who know Dover will remember how the town is cut up by the railway lines to the harbor, and by the Dover and Deal Railway, and have possibly in the past experienced inconvenience at one or the other of the level crossings. In order to improve these conditions a scheme was proposed many years ago, embodying a raised street viaduct, so as to provide permanent communication through certain thoroughfares, regardless of the traffic on the railways. This scheme was authorized first in acts obtained by the corporation of Dover in 1901 and 1912, and the contract was actually let for the undertaking in 1913. As was the case with all other big works, the scheme was interfered with by the war, and has only recently been completed, a series of important tests on the work having been carried out as late as September last, while the engineer's report on them was only submitted at the beginning of November.

The main viaduct has a total length of about 1,000 ft. A spur running from it down to Bulwark street is about 200 ft. long, while a separate over-bridge in Limekiln street has a span of 68 ft. The main viaduct also includes two spans, respectively, of 70 ft. and 65 ft., the one over drainage works and the other over the Dover and Deal Railway.

The whole of this work was carried out in ferro-concrete, on the Monchel-Hennibique system, and Messrs. Monchel and Partners, Limited, Westminster, were associated as consulting engineers for this part of the construction. The contractors were Messrs. Lambrick & Co., Burton-on-Trent, and the whole was carried out under the superintendence of Mr. W. C. Hawke, former borough engineer of Dover. At its conclusion independent tests were carried out. These were conducted by Messrs. D. Balfour and Son of Kingsway House, W. C. 2, at the request of the borough surveyor, Mr. W. Boulton Smith. It may be added that the South Eastern and Chatham Railway Company demanded special tests in the case of the bowstring bridges over their lines, and at these tests representatives of the railway company assisted.

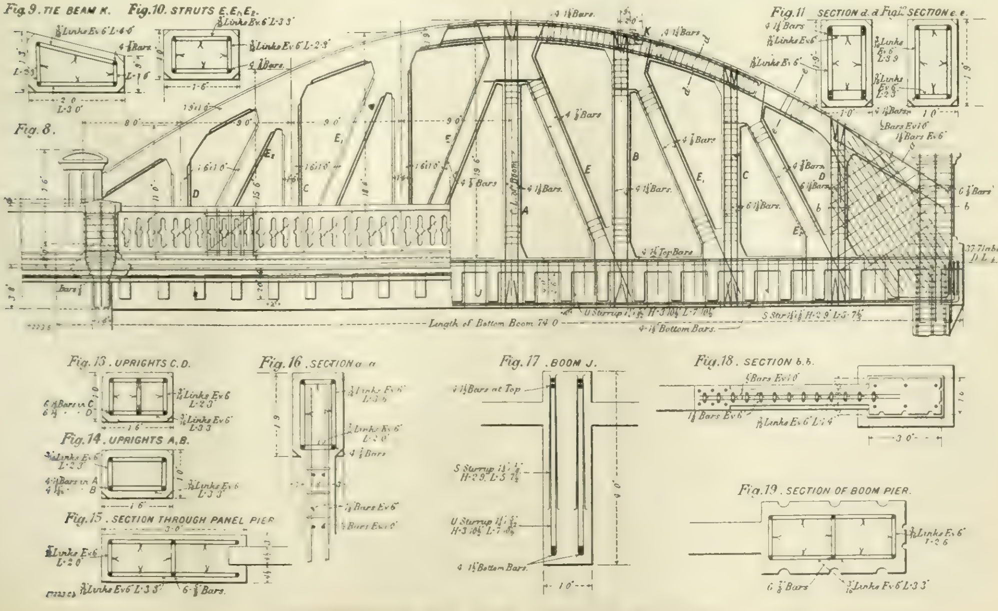
The tests carried out and reported upon by Messrs. D. Balfour and Son were nine in number, while loading conditions during this work were of such a character as to render an investigation possible in a further case, though no actual measurements were taken in this instance. The tests comprised static and rolling tests, and combined tests on various portions, including two of the bowstring girder bridges.

We have selected for illustration the bridge carrying the viaduct over the Dover and Deal Railway. Although this bridge did not involve the longest girders of the three, it was slightly on the skew, and the tests to which it was subjected at the instance of the engineers of the railway company were particularly severe.

Side View of Dover and Deal Bridge.

The clear span of the bridge is 65 ft., the opening being 67 ft., measured parallel with the girders, while the bottom boom has an overall length of 74 ft.

The bowstring girders, one of which is shown herewith, each consist of six open panels and two end panels filled with reinforced concrete. These girders are 23 ft. 6 in. deep at the center, from the top to the underside of the bottom boom. The latter is 4 ft. deep by 12 in. wide, reinforced with four 1½-in. bars at the bottom, and similarly at the top (Fig. 17). The top curved boom is 21 in. by 12 in. in section, the reinforcement increasing towards the center to eight bars of 1½ in. and 1¼ in. diameter (as shown in Figs. 11 and 12). The uprights are 18 in. by 12 in. in section, the central member being reinforced by four vertical bars (Fig. 14), 1⅛ in. in diameter, and the next on each side by 1¼-in. bars. The remaining four verticals are reinforced as in Fig. 13, with



Main Girder and Some Details, Dover and Deal Bridge.

six bars each, the innermost having 1¼-in. bars, and the others 1⅛-in. bars. The diagonal struts are [illegible] and of 18 in. by 12 in. section with [illegible] bars [illegible] towards the corners (Fig. 16). The solid end panels are shown in section in Fig. 18. The panel slab is 8 in. thick, reinforced with 1¼-in. bars placed [illegible] 6 in. apart, while across these are [illegible] bars at 12-in. pitch. Fig. 14 shows the manner in which the panel and top chord are reinforced.

The bridge has a central roadway and outside pathways carried on cantilevers 7 ft. 6 in. wide. The main girders are 41 ft. apart between centers, while from the center line of the girders to the inside of the parapet, on each side of the bridge, is 7 ft. Overhead the girders are stiffened by two beams of a section shown in Fig. 9, annexed. These are 2 ft. wide, and taper from 15 in. on one side to 9 in. on the other, the reinforcement consisting of four [illegible]-in. bars.

The bridge being on the skew, three beams run out at each end. The longitudinal reinforcement is bonded into the facing of the abutments in these cases. The flooring for the roadway is 6 in. thick, with ¼-in. bars spaced 6 in. apart, placed across the bridge at the top, and longitudinally, 7/16-in. bars of 6-in. pitch at the top, and 5/16-in. bars with similar spacing below, with, in addition, 7/16-in. curved bars brought to the top over the beams, and passing to the bottom between them.

The cantilevers carrying the pathway run into an outside longitudinal beam, below the parapet. The ornamental parapet is 5 ft. high. The floor is again 6 in. thick and the reinforcement similar to that of the roadway.

The photographic illustration gives a view from a point to one side of the bridge. The general neat appearance of the structure will be noted, and attention may be drawn to the ornamental panel parapet on the outside. As this bridge spanned the railway, the lines below had to be maintained clear, and for this reason the shuttering, etc., for a great part of the span was carried by trusses standing up above the deck level. As it was not necessary to make provision of the same kind in the case of the drainage works bridge, the shuttering in that case was carried by timbering below.

Tests of the Bridge.—The tests on the Dover and Deal bridge were made in association with the railway company's engineers, and to their requirements. The first test consisted of a load on one of the secondary beams. The load of road metaling supported by such a beam would be 1 ton 10 cwt., the area of floor being 93 square feet. The load for which the viaduct was calculated was 140 lb. per square foot, in addition to metaling. This, on this area, including metaling, would be 7 tons 6¼ cwt. Taking a test load of 210 lb. per sq. ft.—i. e., 50 per cent above the calculated load—the amount would be 10 tons 4½ cwt. In place of this test the engineers of the railway asked for a distributed load of 41 tons, giving an equivalent bending moment to that produced by four wheels loaded with 7½ tons each on a span of 31 feet. This corresponds to a distributed load on the area of about 1,000 lb. per square foot. In order to take the worst case of concentrated load two tram rails were placed over the beam selected, and running in the same direction. Across these were placed sleepers loaded with ballast. The bottom flanges of these rails, placed close side by side, brought the whole load directly over the 12-in. beam. The rails weighed about 1½ tons. In addition, distributed load at the rate of 210 lb. per sq. ft. was placed over the cantilevered portions carrying the footpaths. The deflection allowed by the specification was 1/600th of the span. Loading was commenced at [illegible] p. m. on September 13, and concluded at 4:50 p. m., when the maximum deflection at the middle of the beam, recorded by instruments set below, was 2 mm. The instruments were fixed on a still base, and the deflection was transmitted from the bridge members to be tested, by means of suspended [illegible] rods. In the test now under notice, [illegible] the deflections of the main beams, the maximum deflection of the floor beam was found to be 1.25 mm., or 1/7,4[illegible]th of the span only.

The next test on this bridge consisted of rolling load tests, first one traction engine and three trailers, and then with two trains so composed, side by side, and both passing as close as possible to the girder on one side of the bridge. The traction engines weighed 14 tons each, and the loaded trailers 12½ tons each. The trains were just too long to get onto the bridge completely, and the worst conditions were therefore when the leading wheels of the tractors had just passed off the bridge itself onto the adjacent viaduct. The maximum loading on the bridge under these conditions was 96 tons, and the maximum deflection taken at the center of the middle crossbeam of the bridge measured 1.5 mm., giving [illegible]94 for the crossbeam deflection. The worst deflection for the main girders worked out in this case 1/17,780, and for the secondary beam at 1/21,000 of the span, compared with an allowable 1/600th. No permanent set was recorded. During this test the railway engineers checked the two main girders for spread at the center of the top booms, but detected no lateral movement whatever, the two ferro-concrete crossties resisting such a tendency effectively.

On the bridge over the drainage works tests were carried out with rolling loads. These consisted in the first test of a 14-ton tractor, and three 12½-ton trailers. This bridge has a clear span of 70 ft., and all the wheels of this train, making a total load of 51½ tons, could be got over the span. The second test was made with two similar trains, or a total load of 103 tons. Under the worst load the greatest deflections of one of the main girders was 1/111,250 of the span, and the greatest deflection at the center of the middle cross beam, considered by itself, was 1/15,700 of the span. These compare with the 1/600 allowable.

South African Irrigation Works

Construction of Dam Described by Engineer in Charge

By F. T. PATTERSON, M. Inst. C. E., Engineer to the Board.

From The South African Irrigation Magazine.

Irrigation has been carried on in the Oudtshoorn district for three or four generations and many thousands of morgen have been brought under cultivation by diversion of water by numerous weirs in the Olifants River and its tributaries. Hundreds of miles of furrows varying in capacity from 50 to 5 cusecs lead the water on to the land. These furrows are the private property of individuals or groups of riparian owners. This continual development, together with droughts, has resulted in a great scarcity of water even in tributaries with almost perennial flow, and in 1916 an irrigation district was established for the purpose of the conservation of water and the construction of new canals to bring additional land under irrigation. Subsequently other works, such as new diversion weirs and extension of canals, were decided upon and the scheme has now developed into a comprehensive attempt to improve and remodel the whole of the existing system of the diversion and distribution of flood waters of the Olifants River, as well as the construction of large conservation works on the Kamanassie River, which is the largest tributary to the Olifants River.

The board, elected in accordance with Act 8 of 1912, accepted the scheme prepared by the department and the author was appointed engineer to carry out the works with a loan granted by government. These works therefore fall under that class of organization where the department merely holds a watching brief with regard to technical points and expenditure.

High Concrete Dam.—The works consist of conservation works formed by a dam wall of gravity section 1,265 feet in length with a maximum height of 145 feet from foundation to crest. The width of the wall at river bed level is 84 feet and the thickness at the top will be 8 feet. The main spillway will be on the right flank and will be 300 feet wide with a waste weir wall 600 feet long. There will be an emergency spillway on the left flank with a waste weir 300 feet in length discharging into a channel 150 feet wide.

The estimated quantity of concrete required is 160,000 cubic yards.

The works in the irrigation district below the dam consist of 70 miles of new canals, three new diversion weirs, and the repair and improvement of existing works, with further proposals of constructing or improving 40 miles of additional canals. These works will serve 14,500 morgen, of which only 3,500 is new land.

Progress and Construction Program.—Work on the Kamanassie dam was commenced early in June, 1919, although the first installment of the loan was not received until the following month.

The canals were commenced in January, 1920.

The position of the works at the end of November, 1921, was that 57,000 cubic yards of concrete had been placed in the dam and that the earthworks of 30 miles of canals had been completed, bridges and minor concrete works were well under way, and a start had been made with one of the weirs, and two of the largest syphons were about to be commenced.

Every endeavor is being made to co-ordinate the work in accordance with a program which was drawn up and adopted by the board before the works were commenced. This program provides for conservation to commence with 30 feet depth of water by December, 1921, 50 feet by December, 1922, and the full depth of 100 feet by June, 1923. The remainder of the work to be completed by December 31st, 1923.

The high level canal in Kamanassie Valley will be put into service early in 1922, and the section in the Olifants Valley by the end of 1922; the intermediate canal to Wijnands River in time for the plowing season 1922, and the completion to Vlei River early in 1923. All other works are being proceeded with as finance permits, following out the principle that capital expenditure should be turned to beneficial use as early as possible.

Organization.—The organization decided upon at the commencement—which has been found to work very satisfactorily—provided for engineering and accounts control from a general office at Kamanassie dam and sub-offices on the canals, as construction requires.

This organization was set down in detail on a diagram, a copy of which was supplied to each member of the staff, so that responsibility and control could be clearly defined.

The canal works include many interesting features, but it is necessary to confine the remainder of these notes to the dam construction.

Construction Plant and Accessory Works.—Before deciding upon the period of construction, careful consideration was given to the amount of money the board would be justified in investing in plant and buildings, and it was decided that the plant expenditure should be kept within £25,000, housing of Europeans to £10,000 and natives about £1,000. The period of construction was then fixed at 4½ years with partial conservation within 2½ years of commencement.

As construction was started at a time when it was impossible to obtain machinery from either Europe or America, promptly and at reasonable prices, the board decided to purchase second-hand engines and machinery and get to work as quickly as possible, and only import what was impossible to obtain in this country, therefore the only machinery for which orders were placed were concrete mixers and the air compressor. A three-ton capacity, 1,100 ft. span cableway was obtained from Calitzdorp dam, together with a 40 hp. suction gas engine, two or three small crushers and odd plant. Other gas engines of 115 hp. and 35 hp. were obtained within 40 miles of the site. Three 5-ton locomotive cranes were acquired on a mine and rebuilt at Johannesburg. Other engines, rails, trucks and the hundred and one miscellaneous requirements were obtained from mines about to close down. All this machinery was railed and transported to the site as quickly as possible, and in the meantime an earthen coffer dam was being thrown around the right half of the foundation on the river bed and excavating started by hand methods. Quarries were commenced and labor and material for buildings gathered as quickly as possible.

The layout of the works buildings and plant is such that everything is kept out of the submerged area, and practically all the stores and machinery are on an area of land on the north bank between the dam wall and the main spillway. The works can be completed without having to remove and reset any fixed plant. The general office overlooks the dam wall, and there are telephones to the wall, workshops and stores.

Crushing, Storage and Mixing Plant.—Stone for crushers is quarried in the main spillway channel and run in sidetipping trucks to a reinforced concrete platform over crushers of sizes 24 in. x 19 in. and 16 in. x 9½ in. The crushed stone then falls into gable-end hopper wagons which are run out on gantries and emptied, either into the bins of the mixer station or over the tunnel bin for reserved stone. Sand is delivered to bins in sidetipping trucks and cement is run out on platform wagons and bags emptied into the bins. The mixer station contains two three-quarter cubic yard Ransome mixers and the cement, sand and stone are fed into these through gates operated by hand. The outlets of the cement bins are fitted with adjustable measuring boxes while the quantity of sand and stone is gauged in the charging hopper of the mixers. Water is measured in automatic tanks. The mixers discharge into hopper trucks for running out on the gantry or into skips for transport by the cableway. All rails have been given a grade of 1 in 80 or 1 in 100 in the direction of the load.

Plums or displacers are quarried lower down the spillway channel, loaded onto stone trucks by a 5-ton locomotive crane and run to cranes on the dam wall.

Recruiting Staff and Force.—With regard to staff, labor force and quarters, it was decided that all staff appointments should be advertised; that the European force should be recruited, as far as possible, from Oudtshoorn district, and that housing accommodation for 30 single men and 30 families should be provided. It was also decided that, as far as possible, all unskilled labor should be done by natives brought from the eastern province, housed and fed in the compound.

Housing, School, Recreation, Etc.—The European village has been built on the left or south bank of the river, and all houses have 18-in. rough masonry walls, the single men's, married gangsters' and some of the artisans' quarters have flat roofs. The first class artisans', foremen and staff quarters have pitched roofs with stoeps. There is a school with three classrooms, school principal's house and a combined cafe, mess and recreation room. The sport facilities include tennis court, nine hole golf links and a rifle range.

The natives are housed on the right or north bank of the river in 24 rondavels built in three rows of eight each. These rondavels are of 18-in. masonry walls eighteen feet diameter, eight feet high to eaves and have pitched roofs of thatch. Ventilation is provided by an opening all around the eaves and a ventilator at the pinnacle of the roof. The natives are fed from a kitchen, where the food, consisting chiefly of mealie pap and magouw (fermented gruel) is cooked in steam heated pots.

There are a few married native and colored laborers who reside with their families in another part of the compound. All laborers are under the care and control of the compound manager who is also the camp superintendent and responsible for numerous duties incidental to any large construction job, such as sanitation, first aid to sick and injured, safeguarding water supply, destruction of mosquitoes and flies. This official also controls the police and watchmen and looks after the stables.

There is a postoffice and telephone exchange in the general office, and when this is closed the residences of the engineer and compound manager are connected and linked up with Oudtshoorn police station.

The matter of transport has, fortunately, caused little trouble. The railway administration gave special facilities at Van Wijks Kraal siding, about 8 miles from the works, and, although the cost of a branch line or mechanical transport was looked into, it was very soon realized that the humble donkey wagon could do the work most economically and that there would be no need for the board to invest in wagons and animals, as sufficient wagons could be obtained to undertake transport at reasonable piecework rates. There has been no delay due to lack of transport, either of materials from the railway or sand from the river.

An early start was made with the accumulation of sand for concrete and a large stock has always been on hand. At one time this amounted to no less than 12,000 cubic yards.

Construction Methods.—Having dealt with the preliminary work incidental to construction, a brief description will now be given of the methods of building the dam.

The foundation in the right half of the river bed was first excavated inside a coffer dam and the flow of the river confined to a width of 200 feet near the left abutment. A cutoff trench was carried down to a greater depth than the normal foundation, and by the 6th of May, 1920, this was sufficiently far advanced to permit concrete being placed. This was commenced by two Bantam mixers working in the foundation and supplied with stone crushed by a portable crushing outfit, pending the completion of the crushing and mixing stations. On this, the first day of the actual building of the wall—the staff and children attending the works school assisted by the simple ceremony of dropping small stone "plums" into the first concrete placed in the foundation.

By September 2, 1920, the foundation of the right half of the river bed was sufficiently advanced to permit of the discharge of the river to flow over the completed portion and to allow the left half being enclosed by coffer dams.

The left half of the foundation presented greater difficulties as there was more water to be pumped and the cutoff trench was of increasing depth as the left abutment was approached. This was due to a clay joint at the contact between the grey rocks and the slates. At this date (September, 1920) a start had been made with the next lift of the dam wall by erecting two 5-ton locomotive cranes on the upper dam about 20 feet above the river level. This lift was carried forward by running concrete from the mixer station on a gantry, and the two cranes placing plums and gradually travelling towards the center of the river. This method permitted the completion of the foundation on the left half and concrete up to river bed level, before the flood channel over the right foundation was entirely obstructed by the encroaching second lift; therefore the work of excavation was carried on day and night for about two months and concreting of the left cutoff trench commenced in November, by cableway and Bantam mixers, but progress was not as good as was expected and the steady approach of the second lift from the right flank increased the risk of damage to the coffer dam in the event of flood occurring. The question was then whether to play for safety and stop the progress of the second lift, or take the risk by allowing it to come forward. The latter course was adopted with the fervent hope that the summer thunder-storms would be light. The river, however, was not going to be brought under control without a final kick, and in February several freshets, culminating in a sudden flood of 10,000 cu. secs., broke the left half coffer dam, overturning engines, pumps, etc. Things looked black for a few days, but fortunately most of the cutoff trench had been refilled with concrete, and after getting engines and pumps to work again, concreting was proceeded with within a small coffer dam, near the left flank, thus leaving the center of the river clear until the summer rains had ceased. No further serious trouble was experienced and the river was diverted through one of the culverts at the end of July, 1921. Since this date a small quantity of water has been stored in the reservoir for the requirements of the work during the dry season.

The second lift reached the left abutment at the end of October, and early in November the two locomotive cranes were raised another 20 feet and are now traveling back to the right flank on the third lift.

After the commencement of conservation, small floods will be controlled by the operation of ten 36-in. sluice valves, and during the wet season, a section of the wall will be kept at a lower level than the remaining length in case of a large flood filling the reservoir.

Costing System.—The costing system is arranged in such a manner as to give the most satisfactory results under the three main heads of (1) Conservation Works, (2) Canals and Weirs and (3) General Expenditure, and these are again divided into principal features designated by letters of the alphabet, viz.:

A to J cover the features on the Conservation Works; K to S those of Canals and Weirs and X to Z General Expenditure.

These symbols are again divided into heads and subheads [illegible].

Depreciation on plant and temporary buildings is written off every month.

With this system the accurate detailed unit cost of any subhead or section of work is readily obtained every month.

The number of men employed at present is about 450 on the dam and 300 on canals. The total number employed last April was about 1,800 on the whole works, but the financial stringency necessitated drastic cut down along the canals. Additional funds having now been provided, progress will be expedited.

Concave Roads.—Certain English engineers are advocating the general installation of roads which are concave, and drain to the center instead of the reverse, as is usually found under ordinary conditions. It is argued that with the slope toward the center the concrete when expanding under the action of heat or moisture will have to move uphill against the force of gravity, and that on contraction gravity will assist it and tend to save cracking. Reinforcement is a part of the system proposed.

Coast Preservation Works in British Guiana

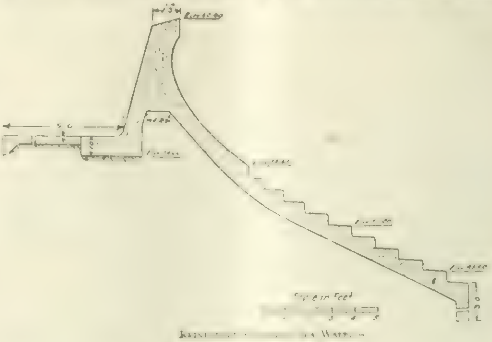
Rigorous Measures Bring Success After a Long Series of Failures

By HERBERT L. VALLEY

From Concrete and Constructional Engineering, London

The notable achievement described in the following pages is remarkable in two respects: it is the largest work of its kind in the world, involving a total expenditure of over £1,000,000, and it represents the solution of an exceedingly intricate problem in coastal protection, which, since 1750 when the colony was in the hands of the Dutch, has defied engineering skill effectively supported by lay ingenuity.

Early in 1916 the Commission sitting to consider the acute question of immediate "sea defence" decided to discontinue former methods, and to obtain expert advice. Shortly afterwards Mr. Gerald Otley Case, A. M. I. E. I. C., Assoc. M. Am. Soc. C. E., M. S. E., was called in to report on the matter. As a result of his investigations and recommendations he was appointed Consulting Engineer to the Government of British Guiana, and instructed to prepare, and subsequently supervise, the scheme which is the subject of our articles.



Section of New Sea Wall.

Early Methods of Protection.—Although British Guiana can hardly be said to obtrude itself either upon the man in the street or the keen student of Empire geography, it is a colony of considerable importance, being rather larger than Great Britain. Not being an island, however, its coast line cannot compare with that of the Mother Country, being, indeed, no more than 135 miles in length. Nevertheless the health and wealth of British Guiana are entirely dependent upon the solidarity and soundness of her shores. This is due to the fact that practically all the land abutting on the sea is from 2 to 4 ft. below high water level, even Georgetown, the capital; and the principal sugar estates, are several feet below water level at high tide.

The question of permanent and impregnable coastal protection was, therefore, one of supreme importance, and of recent years it has become a matter of extreme urgency, owing to the accelerated rate of erosion, and the consequent deluging of cropped lands and estates.

Some idea of the seriousness of the position may be gained from a perusal of the following records. From 1792 to 1874 the average rate of erosion was 10.57 ft. per annum,* from 1874 to 1890 it was 79.00 ft. per annum, and between 1890 and 1916 it was 23.80 ft. per annum, while during the corresponding periods the accretions were almost negligible.

Each year, though every endeavor was made to check the steady encroachment of the sea, saw a further retirement before the invader; landmarks and boundaries had to be removed further and further from the coast, and in not a few cases valuable estates had to be completely abandoned.

Enormous sums were expended in unsuccessful attempts to combat the regular advance of the sea; indeed, shortly before the present work was put in hand the amount expended annually upon the maintenance of the coastline exceeded £55,000. Unfortunately, most of this sum was spent on the erection of bulkheads, vertical sheet piling, wave screens, improperly constructed and uselessly situated groynes, wood fascines, earth dams, etc., and the result, as is clearly demonstrated by four successively abandoned lines of sea defences at Lusignan, has been disastrous. And this is not an isolated instance. All along the coast a similar state of things existed previous to 1916—the whole panorama presenting a sorry history of costly failure, and a dismal picture of sea-conquered territory.

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*The low average of the period was due to the formation of the [illegible] Spit, a natural barrier having a maximum width of [illegible] ft., which subsequently disappeared.

The lack of success which attended all former endeavors, though deplorable, was in no sense a reflection upon those who undertook the work; they, indeed, were in no small degree the victims of circumstance. It could scarcely be expected that a Director of Public Works—whose duties in such a colony are multifarious—could with reasonable prospect of success tackle a problem which taxes the skill, experience, and ingenuity of the expert and specialist to the utmost. Moreover each successive official acting in this capacity had neither sufficient reliable data nor adequate funds to deal with the matter basically. They had, therefore, to content themselves with schemes dealing with effects rather than causes.

It was not until 1915, when numerous and extensive sea encroachments involving the abandonment of many large plantations and estates revealed the seriousness of the position, that the Governor, Sir Walter Egerton, K. C. M. G., appointed a special commission to consider the whole question of coast protection. In fairness to those in authority, previous to the date given, it should be pointed out that the danger in which the colony stood had not gone unperceived, and many and vigorous appeals were put forward advocating immediate and purposeful action. Previous to the appointment of the Hon. E. C. Buck, the present Director of Public Works, those in charge of this department had repeatedly drawn attention to the perilous position and the insufficiency of the existing "sea defenses," while he himself has forcefully urged the instant adoption of a policy based upon more scientific methods.

Another factor militating seriously against the success of this enterprise was the lack of co-ordination; work was done piecemeal, and even then was not properly maintained. The problem, too, was further complicated by the ill-considered action of those occupying estates adjoining the shore; each owner being anxious to obtain security for his own acres took steps to divert the destructive action of the sea to his neighbor, with the result that the whole foreshore became irregular, and the condition which all were anxious to abate was aggravated.

In short, the continuance of coast erosion was due to the lack of a firm policy, backed by special knowledge of the subject. Few engineers who have not specialized are aware of the existence, or nature or operation of innumerable destructive forces which by their incessant action ultimately lead to the obliteration of littoral boundaries, and the inundation of hundreds of thousands of low-lying acres.

Dam Faced with Reinforced Concrete (10 Steps).

Few engineers who have not made coast erosion a special study realize the enormous part played in shore alteration by wave, wind-formed currents, tidal currents, currents caused by estuaries, rivers, and drainage outlets, and by wind action; few also realize the tremendous influence which dead trees, the destruction of vegetation, the removal of sand, gravel or shell, rain, changes in the sea bed, the use of vertical sheet piling, wave screens, high groynes, stone-filled groynes, or other incidental or artificial obstructions to littoral drift, have in shaping sea boundaries.

It is not strange, therefore, that all previous efforts—which were put forth without full and proper knowledge of the controlling conditions—were foredoomed.

The Present Scheme.—The consulting engineer responsible for the design and supervision of the present scheme had, therefore, to begin, as it were, at the beginning, and institute careful and detailed investigations into the origin and causes of the condition in which he found the coast. This meant extensive and tedious research covering a very wide range of subjects indirectly connected with the problem, and a close personal scrutiny of the conformation, outline, and geographical features of the entire foreshore.

New Sea Wall on East Coast.

As he anticipated from cursory observation, Mr. Case discovered that, to a very large extent, the actual damage caused, and the unsatisfactory state of the coast generally, was due to the manner in which the sea-defenses had been designed, and also to the actual location. Methods adopted prior to 1916 were not only inadequate, but actually aggravated the original trouble by providing a position about which the scouring action of the sea could concentrate itself. This, in point of fact, is what happened. Behind every range of sheet piling, and on the leeward of groynes, fascines, etc., large hollows were formed which in time completely undermined the structure, and merely intensified the difficulties to be overcome.

It was, therefore, decided that all previous attempts should be ignored—from the point of view of their utility—and that a more scientific system should be adopted. As a result Mr. Case prepared the scheme which is the subject of these articles.

The Work Involved.—As the matter was extremely urgent—so urgent, indeed, that both the British and American governments readily granted special priority permits for materials to be shipped during the most critical period of the war—Mr. Case decided to proceed at once with the permanent protection of some 52¼ miles of coast on which the occurrence of serious and extensive damage was, if not imminent, at least distinctly possible.

This involved the provision of:

111 specially designed, low, reinforced concrete groynes. Some being 750 ft. long, spaced at 1,500 ft. apart; others being 500 ft. long, and spaced at 1,000 ft. apart.

25,400 lin. ft. of reinforced concrete sea walls.

24,400 lin. ft. of reinforced concrete sluice runs, and sluices.

46,000 lin. ft. of earth dams.

28,950 lin. ft. of public road diverted to accommodate the scheme, the estimated total of the whole being 1,753,100 cu. ft. of reinforced concrete; to which should be added a large quantity of concrete and cement used, as it were, incidentally.

The total cubic content of the wood used in this structure, [illegible] sheet piling, wave screens, etc., could not be estimated as more than half of the material used even in the most recent protective scheme had been destroyed and carried away by the action of the sea.

The System and the Design.—The system selected to deal with the special and intricate problems which presented themselves for instant solution was that devised by Mr. Case's father (the late Edward Case, A. M. I. C. E., F. R. G. S.), formerly of the Public Works Department, and the scheme herein described was carried out in strict accordance with the principles laid down by Mr. Case, senior, i. e., the low groyne, set at a special angle relative to the littoral boundary coupled with the employment of a curved sea wall, having a varying elliptical section, rising, as it were, from a stepped foundation. Since the design of these features is almost entirely dependent upon local conditions, it is difficult to furnish a section which may be regarded as representative or characteristic. Nevertheless the illustration will give a fair idea of the typical curvature.

The basic idea underlying the system adopted is to use, and not to oppose, the forces of the sea so that in various ways the foreshore may be built up in a "natural" angle over which the waves may roll harmlessly, expending their energy before reaching the high water mark.

In detail Mr. Case's investigations led him to the conclusion that, with the materials available, and under the adverse circumstances then obtaining, nothing less than the following could be regarded as protective work calculated to produce an efficient safeguard to the steady encroachment of the sea, and in his report to the British Guiana Government he strongly advised that the items enumerated below should be proceeded with without delay:

1. Where possible, to straighten the line of protecting dams by abandoning the existing outer protecting dams, and building new dams further inland.
2. Reinforced concrete sea walls, in place of earth ones, should be built on the most exposed parts of the coast.
3. Where the earth dams were liable to be attacked by wave action to face them with reinforced concrete.
4. Construct new reinforced concrete drainage sluices in line with the sea wall or concrete-faced earth dam.
5. Construct training walls or groynes on each side of the drainage outlet to guide the water direct to sea.
6. Construct a system of low groynes in front of all exposed sea walls.
7. Remove all existing structures, such as wave screens, high groynes, and vertical sheet piling, which were causing erosion.
8. Encourage the growth of suitable vegetation in front of the dams.
9. Prohibit the removal of shell from the front of the sea dams.
10. Prohibit the destruction of any useful vegetation.

French Try Concrete Sockets to Prolong Life of Wooden Poles

[illegible] of prolonging the life of timber posts such as are used for telegraph, telephone and electric power cables, [illegible] type of reinforced concrete socket has been introduced in France. The socket is constructed [illegible] of which the lower part is [illegible] the ground to a depth of from [illegible] and the upper part, projecting to a height of from [illegible], con[illegible] a support for the base of the timber post. [illegible] plate. [illegible]

Stability of Deep-Water Quay Walls

By F. E. WENTWORTH-SHEILDS.

Abstract of paper read Dec. 13 at a meeting of the Institution of Civil Engineers, London.

In this paper the author points out that, in spite of all that has been written on the subject, no general agreement has been reached as to the best way of estimating the forces and resistances acting on a retaining wall with earth backing and on an earth foundation. The solution of such problems is so unsatisfactory that many engineers discard their calculations, even when they have made them, and trust to their judgment in deciding whether a wall as designed will be stable. This is especially true of deep-water quay walls, whose problems are quite different from those of land walls, owing to the presence of water which creeps underneath and behind them.

A quay wall may be considered an acted upon by certain outward horizontal forces, such as the lateral pressure of backing, etc., which must be balanced by inward horizontal forces, such as the pressure of water in front of wall, the lateral resistance of earth in front of the toe, the resistance due to friction at the base, etc. It is also acted upon by certain vertical forces, of which the downward forces, such as the weight of the wall, etc., must be balanced by the upward forces, such as the upward pressure of water and earth beneath it. Moreover, the sum of the moments of all these forces about any point must be zero, or the wall will overturn. As regards the outward forces, the most important is the lateral pressure of the earth backing, for estimating which engineers generally use Rankine's formula. Mr. Crosthwaite's experiments show that to obtain accurate results with sand the value of ϕ should be greater than the angle of repose, and Mr. Bell has shown that the formula needs modification in the case of clay. If the backing is flooded, it is suggested that the intensity of its pressure should be estimated as that of water, whose free surface is at soakage level, or of the earth alone, whichever is the greater. Loads on the quay are generally taken at about 2 cwt. per square foot, and heavy point loads may be regarded as dispersed over a certain area. The pull of a ship on the bollards may also be considered as dispersed over a certain length of wall.

As regards the inward forces, it seems right to include the pressure of water in front of the wall at its lowest level. Rankine's formula is generally used for estimating the resistance of the earth in front of the toe, but here again, in the case of sand, Φ has probably a higher value than the angle of repose, and clay calls for a modification of the formula. It seems doubtful whether water overlying the earth in front of the toe can be considered as increasing its resistance. A sloping base to a wall would appear to produce an inward resistance. As regards friction between the wall and the earth beneath it, this is generally obtained by deducting the other inward forces from the outward forces. The result ought to be definitely less than the permissible friction, which is usually estimated by multiplying the weight on the base, less the upward pressure of water under it, by a suitable coefficient. Such co-efficient in the case of clay may be little or nothing. The vertical downward forces are generally assumed to include all materials—masonry, earth, and water—directly over the base. The friction between the backing and the back of the wall is usually ignored, though in certain cases it may come into play. The upward vertical forces are generally assumed to include pressure of water under the base due to a head equal to the height between the base and the lowest water level. The friction between the toe and the earth in front of it is commonly ignored. The remaining force, which is the upward resistance of the earth under the wall, is found by deducting the other upward forces from the downward forces. Then by taking moments of all forces about any point, the position of the resultant of this earth resistance can be found and hence its greatest intensity. This again should be definitely less than the permissible resistance or bearing power of the earth, which is estimated in various ways, and in many cases can be determined by experiment.

Some devices for stabilizing a wall, such as widening or deepening it, stepping its back, lengthening the toe, removing part of the backing, are considered from the standpoint of theory and of experience.

Arched Bridges of Wide Span

An Austrian Engineer's Demonstration of Possibilities in Stone and Concrete Beyond Ordinarily Accepted Limits

Summary of a Paper Read Before the Swedish Concrete Institute in Stockholm in 1921

By DR. F. von EMPERGER.

Reprinted from Concrete, London

A historical survey of the development of arches in bridge construction shows that the masterpieces of the Romans in this field of work have not been excelled up to most modern times, for whilst French engineers, as far back as the middle of the eighteenth century, constructed several fine bridges on the lines of the numerous and well-preserved patterns of Roman art in France, these later structures can only be described as adaptations of the older ones, and—notwithstanding the modern development of the theory of structures—the bridges, aqueducts and cupolas of the Romans of nearly twenty centuries ago are still equal to the corresponding structures of today.

The use of cast iron since the end of the eighteenth century in England, brought about a temporary departure from stone as a building material for bridges, and a number of famous bridges in various capitals of Europe bear witness to this period. The economic superiority of steel bridges at the present day compared with massive arch bridges is chiefly due to the lower prime costs of the former. Steel bridges are equally suitable for medium and for wide spans, but the supposed limitations of the span in other materials forms the chief obstacle to the general use of arches in stone, concrete, etc., and massive arch bridges of these other materials can only be of economic advantage if the difficulty of wider spans with flatter arches were to be overcome. To show that this difficulty no longer exists is the purpose of this paper.

The Use and Abuse of Hinges.—The extensive use of hinges in metal bridge construction led to their introduction in stone arches by Köpke in the year 1880, and this, and a development of the theory of arches, led engineers to avoid designing statically uncertain and less-known fixed arches. Whilst, in the following lines, I dwell upon the advantages of hingeless arches and recommend them as the means by which greater spans may be attempted, I do not fail fully to appreciate the advantages of hinges, and only avoid them where they are not absolutely necessary and create an unnecessary weakening of the arch. The use of hinges is chiefly necessary in order to take up all changes and movements caused by settlement or shrinkage, yet a properly constructed arch will cease to move within a short time after the striking of the centers, and there is consequently little or no necessity for joints in the finished structure, as an arch is the ideal shape for absorbing subsequent movements due to temperature. It is quite a fallacy to consider joints necessary for the construction of wide spans, and my personal experience has taught me that such joints are quite superfluous, even with bad foundations, always provided that the latter were properly designed at the outset or that they have settled prior to the bridge being built. In all such arches the joints could be fixed later and the bridge thus converted into a monolithic structure, but if this were done, every care must be taken when the temporary joints are filled in with concrete, as the arch must be given a suitable form and proper arrangements of the reinforcement must be made, to allow for all stresses due to temperature.

Pioneering in Reinforced Concrete.—Reinforced concrete was used in the construction of arched bridges in the year 1885, but there were several collapses as a natural consequence of the engineers concerned not making use of breaking-tests. Praiseworthy pioneer work was done in this respect in the year 1890 by the Austrian Committee for Arch Construction which experimented with arches of 66 ft. span, and whilst many expectations were not realized as far as the size of span was concerned, these experiments showed that there was no need for apprehension with regard to tensile strains.

Of the reinforced concrete bridges of the period, the Orelf Bridge (Fig. 1) of 300 ft. span and 1:3:2 pitch, is the largest main arch at present existing. It is a hinged bridge, but stone bridges like the Syratal Bridge (300 ft. and 1:5 pitch), the Luxemburg Bridge (280 ft. and 1:2.7 and the Isonzo Bridge (283 ft. and 1:3.9), which are all of the fixed type, make it sufficiently clear that no necessity exists for the use of hinges, especially as the flattest arches with a pitch of 1:12 were constructed on the fixed system, notwithstanding the fact that hinges are of greater importance with flat bridges. Hennebique, too, largely rejected the use of hinges; his largest bridge before the war was the one in St. Chaude with 220 ft. span and a pitch of 1:12; his flattest bridge had a pitch of 1:17. The greatest span actually used up to now is the bridge in Minneapolis of 407 ft. span and 90 ft. pitch, which is likewise of the fixed type and like all large bridges of this type has a high pitch.

Regarding Pitch, Span and Clearance.—If a large pitch of 1:6 and less are to be generally adopted, it would involve such great heights for clearance, special rock foundations, etc., that the use of such arches of such wide spans would be very rare and would only be used extensively if greater spans with a pitch of 1:10 could be erected on the common subsoil. If we increase the span of a structure it follows that all other dimensions must be correspondingly increased; this is no peculiarity of arches but is applicable to other building elements, and this is one way in which the difficulty of wide span and stresses due to deadweight can be overcome in arch bridge construction. On the one hand, stronger construction of the abutments, and on the other a reduction in weight by giving the center of the arch a slender form and building it of special pressure-resisting materials, and my chief task is, therefore, to discuss an arrangement which will increase the dimensions of the abutments, and reduce those at the center of the arch so that all stresses will remain within safe limits.

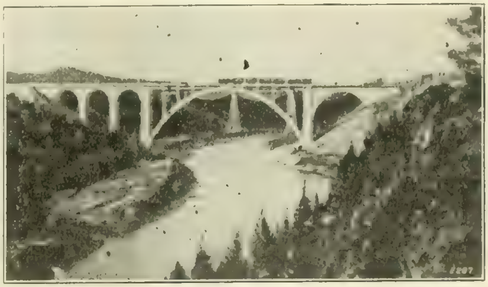
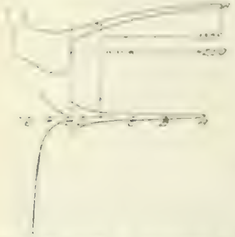


Fig. 1—Orelf Bridge.

Under ordinary conditions, an increase in the dimensions is naturally followed by an increase in the deadweight, and with larger arches the influence of the deadweight is practically the only factor of importance for the dimensions, and as it follows that the increase in the stresses can become greater than the increase in the cross section we soon arrive at a point at which the increase in the dimensions becomes useless, and only an increased resistance will lead to a solution of the problem.

Moments of Inertia and Limits to Span Length.—Several engineers have endeavored to ascertain what is the greatest span which can safely be used for a single arch, and have considered 500-700 ft. as the maximum, though they have not shown any method of construction which (conditioned by the course of moments of inertia) was most suitable for the same. From a study of particulars of various well-known fixed arches collected by my collaborator, Mr. Gerhard Newman, I have found the ratio of moments of inertia from the crown to the base varies from 1:1 to 1:2.5, and Mr. G. Newman —who has examined the course of the maximum stresses at the edge for the whole arch of a recent design by Professor Melans, i. e., the bridge of Chauderon-Montbenon, which shows a ratio of moments of inertia from crown to base of 1:15—has arrived at the remarkable conclusion that with this arrangement, the positive and negative maximum stresses show such nearly equal values that the arch is of constant rigidity, notwithstanding the fact that the crown measurements are the smallest amongst a large number of those in existing bridges. This new arrangement therefore makes it possible to increase the span and shows the way to find new economic shapes for such great spans.

In connection with this, Fig. 2 shows the course of the moments of inertia in the case of the Schwarzenberg Bridge at the Building Exhibition of Leipzig in 1913 and enables us to judge how firmly the arch is fixed into the abutment. The moments of inertia calculated in the usual way for the points A, O and G, bear the ratio 1:5:16,000. The center section consists of two ribs of about 225 sq. in. of surface (10 in. wide by 22½ in. high) and the width of the bridge is 16 ft. 5 in. If we compare the figures with the bridge at Minneapolis, the largest arch in the world, which (reduced to the same bridge-width) has 90 sq. ft. or 64 times the section in the crown, then we must conclude that this increase of section is quite out of proportion to the span, which is three times as large; and this is the more remarkable as the pitch (1:4.5) of this largest bridge is far more favorable than that of the Schwarzenberg Bridge (1:7.5). A comparison of these figures clearly shows that there is a wide margin for the reduction of dimensions in the centers of these large arched bridges, and that their bulky and heavy construction is quite unjustified. By an arrangement such as that shown in Fig. 2 the arch proper is transposed between points A and O, and the clear distance of 142 ft. between the abutments is reduced, by means of the two consoles of 13 ft. each, to a span of 113 ft., i. e., to 80 per cent.



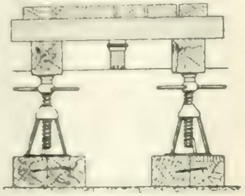


Fig. 2—Course of Moments of Inertia in Schwarzenberg Bridge.
Fig. 3.—Loading Arrangement.

Austrian Committee's Tests.—A further reduction can be obtained in future bridges, as the necessary tests have only been made since the bridge shown in Fig. 2 was built. A promising beginning was made during the years 1908 to 1912 by the Austrian Committee on Concrete-Steel Construction, under whose supervision tests were made with fixed beams supported by a 24-in. wall, the beams being fixed into the wall partly with and partly without enlarged or skewed ends.

In all these experiments one and the same center section was first of all examined, by means of the test load arrangement as shown. This center section may be considered as that of half a plate 1 ft. in width. The tests may be taken as corresponding to very flat arches, the skews at the supports corresponding to extended abutments of arches. The moments of resistance of a reinforced concrete section in the center as well as at the point of fixture were actually measured and were not merely calculated.

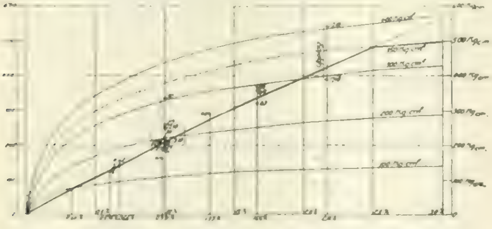


Fig. 4—Results of Tests on Freely Supported Beams.

Note.—The curved line indicates bending resistance after six weeks ([illegible] Beams).

Fig. 4 shows the result of the tests on freely supported beams. The usual calculation for the breaking stress of a section which permits a tensile strength for iron of 54,000 lb. per sq. in. holds good in all cases except those beams which are enlarged at the supports. The equation

$$M = \frac{ql^2}{8} = W \cdot \sigma = W \cdot 5923 = 229\,000 \text{ Kg-cm.}$$

which gives that moment of resistance for the section as being correct.

Fig. 5 depicts the cracks in freely supported beams with enlarged ends and underneath a typical picture of the shape of the beam, from which may be seen the resulting reduction in the span through the adoption of skew ends.

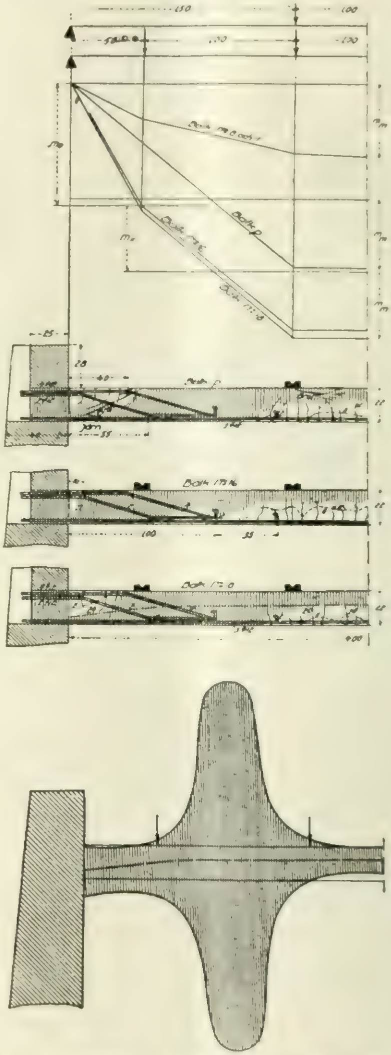


Fig. 5—Diagrams of Beams Without Skew-Ends.

An attempt was made to ascertain as to whether and how it would be possible to reduce the moment $\frac{ql^2}{8}$ for supported beams, by means of fixation to $\frac{ql^2}{24}$, or, in other words, to treble the carrying capacity of the beams. The supporting beams had a breaking load of about 40 tons, corresponding to the moment of resistance of 3,220,000 lb. sq. in., so the reinforcement was arranged at the place of fixation in such a way that it would correspond to about double the moment of the center, i. e. $\frac{ql^2}{12}$. Fig. 8 depicts the measures taken to fix these beams into the built-up abutments.

Several of the tests were made in such a way that the fixing was somewhat weaker but never stronger, as it was not thought possible that these small provisions could do more than to take up and distribute the totals of the moments so that the sum of the moment (M_m) at the center and the moment of the point of fixture (M_o) was otherwise than $M_o + M_m = \frac{ql^2}{8}$, which was considered as a definite formula. At first it was thought necessary to adopt the usual practice of loading the brick supports as well, but this, as well as the particularly careful bonding, proved later to be quite superfluous. The favorable results obtained were repeated with the simplest methods, and proved absolutely reliable. After the suspended beams were broken at 4 tons, it was to be expected that a fixed beam would have a breaking load of 12 tons, but the actual records show an increase to 16 or 17 tons throughout in tests without the skew ends and an increase to 25 to 27 tons in tests with skew ends with an equal moment of fixation. These results came as a pleasing surprise, as it was at that time the undisputed opinion in the profession that the effect of fixation upon the center of a beam would at best be $\frac{ql^2}{24}$, and that, moreover, a complete fixture was very difficult to attain. To my deep regret, lack of means prevented further investigation of this important matter by further experiments on broad and extensive lines.

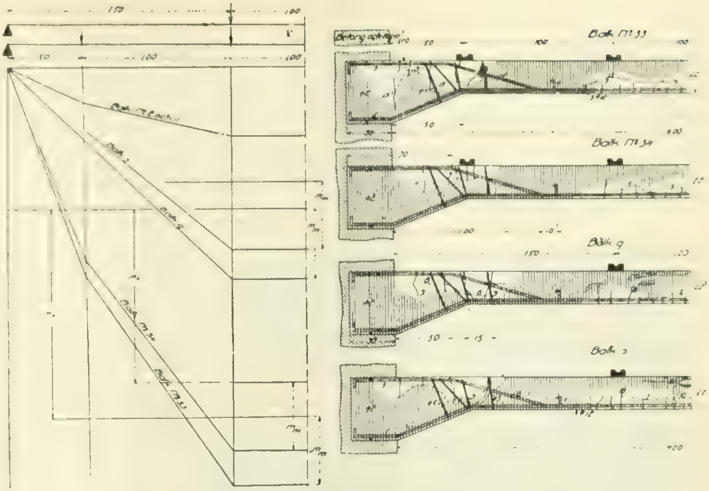


Fig. 6—Beams with Skew-Ends.

This need not hinder engineers from using the knowledge, clearly proved by facts, that a considerable reduction in the width of span of the center beam can be obtained if the fixation is made in such a way as to provide a console-like connection of the abutment with the outer parts of the supports. The proof of the correctness of this assumption is shown by the fact that loads placed on the consoles have practically no influence upon the center span. Owing to lack of means, only a simple proof was possible. Figs. 6 and 7 show that by omitting the two outer of the four loads representing the total uniform load, the surprising result that the load capacity of the first beam was reduced from 17 to 8 tons and of the second beam from 27.9 to 9.5 tons was obtained. In both cases, and with and without the skews, an excess of the M_x moment resulted: which can neither be explained by the known moment of resistance of the two sections at the center and at the point of fixation, nor by any other adjustment. The figures show what the result would have to be if for purposes of statical investigation the clear width were retained as width of span and if the influence of the horizontal drift caused by the frame support were not taken into calculation. This assumption is evidently incorrect, and a much smaller width of span must be taken as a basis for the moment of the center if the efficiency of the center section is to be considered. Fig. 6 gives a summary of some experiments without skew ends, and Fig. 7 one with skew ends, and the plans of rupture lines underneath show the effect of 2 and 4 loads. The quantity for M_x was found from the results found for M_m and M_o as shown by the tests. Fig. 11 gives the effect of the fixation and the deflections which took place in the center of beams of different shapes under one and the same load.

This comparison load was, with freely supported beams, assumed to be somewhere in the neighborhood of the breaking limit, and it will be seen that the deflection of the fixed beam is quite insignificant. Several experiments were also made with continuous beams, as shown in Fig. 8, and here also the incorrectness of the original assumption about the rectilineal form of the axis and the similarity of the course of the moment of inertia was proved and the favorable influence of these circumstances upheld. To what an extent this knowledge touches all branches of building construction may be seen in Fig. 9, which shows results of these experiments with the so-called "mushroom" flooring. These tests seem to prove the correctness of the contention of American engineers who negative the influence of two adjoining fields of mushroom flooring as given by an ideal continuity.

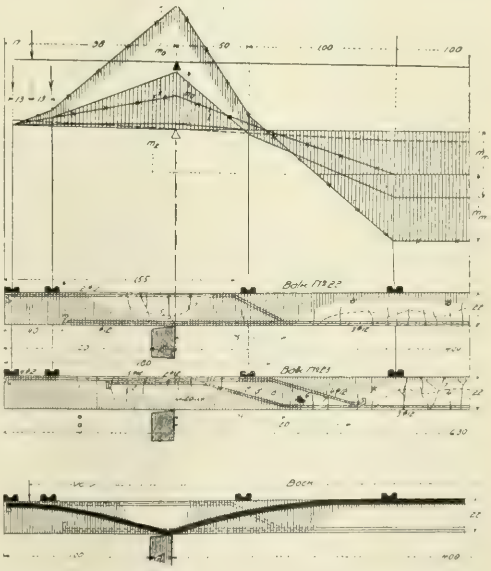


Fig. 7—Continuous Beams.

In their calculations they assume that the fields are carried singly by the consoles, the part of the bonding of which is clearly shown in the illustration, and they are evidently guided in this by the view that this method of calculation better corresponds to facts. The other extreme, i. e., that no continuity exists and that no transfer of strains from the neighboring span takes place, is equally incorrect, but at the same time more serviceable than the present day assumption. In this connection, it is necessary to say that with the experiments of the Austrian Concrete Committee the bondage of the tested beams must not be overrated; the ends of the beams were by no means invariably fixed in the true horizontal position. The angle of the departure from the horizontal was ascertained by exact measurement at the abutment, and found to be fairly considerable, proving that even in the experiments the fixation was not perfect. As a matter of fact, the fixation of an arch to its foundation as shown in Fig. 2 is far more reliable. When treating the whole of the test pieces as a frame system, it must be remembered that the arch was about 1 : 4.

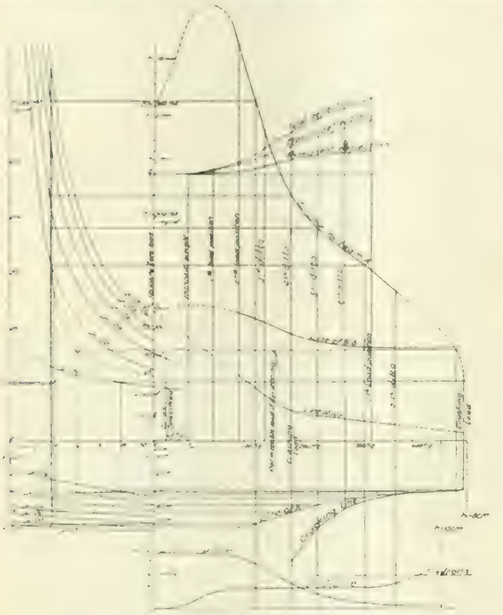


Fig. 8—Course of E. I. In Control Beam.

Other Experiments.—Other experiments on the determination of the true value of the moment of inertia, or the moment of resistance respectively, which in the usual calculation, with $n = 15$, is considered correct, and likewise in the second stage for the whole framework, were reported in detail in Beton and Eisen, 1916, in which the reduction of the moment of inertia of a reinforced section together with the increasing tension until rupture occurs, is extensively dealt with. The well known formula for deflection (f) in the center is $= \frac{Pl^3}{EJ}$ In regarding this formula as significant for the change of form in the whole beam, it is of great importance to have exact knowledge of the true quantity of EJ. It is usually assumed that this quantity is the same over the whole beam, but the influence of an alteration of this quantity is, in case of a freely supported beam, chiefly dependent from the center part and it can also be proved (Figs. 5 and 8) that the influence of an alteration of EJ at the point of support of a freely supported beam is by no means so insignificant as may be thought.

Fig. 10 shows the course which EJ takes in a control beam with a load increased gradually to destruction, and the enormous difference which takes place within the range of the safe load will be noticed, and in practice there is no beam with a uniform EJ. This difference in the case of the freely supported beam only comes into consideration at that change which takes place near the supports between stage I and stage II. This is usually disregarded, but it must not be neglected with beams where the change of tension is near the center as is the case with a beam fixed at the ends or with arch. In a fixed beam, stage I with its enormous moments of inertia will remain at the place where the change of tension takes place, and will make itself felt like a partition between the center part of the beam and the console connected to the abutment (Fig. 6), and conditions may then occur to cast doubt on the value of the connection between the center part and the two outer consoles of a beam and considerably reduces the effective width of span of the center part. For this reason it is very doubtful whether the continuity, or better, the homogeneity of a beam is maintained constant until the rupture point is reached.

Loads may be added or taken away from the sides without in any way affecting the center. The beams examined had, through their walls, sevenfold the bearing capacity of the freely supported beam when with skews and fourfold when without skews, instead of only a threefold increase as would be expected according to theory. Hence a beam which, when freely supported, may rightly have a span of say 100 and which, when perfectly fixed and bonded, would allow, according to theory, an increase of the span to 173, would, according to the tests mentioned above, allow a span of 200 and 265 respectively with and without skews.

These tests prove that without skews the bearing distance of the center is reduced by about half and by aid of skews by about one-third; this gives wide possibilities of economic importance of which full advantage should be taken in the present shortage of iron for considerably reducing the costs of building.

There are very few analogous tests on arches and these are not to the point, like the older tests with beams. On the other hand, in the tests described above, the beams may be practically considered as flat arches of about 1 : 20 and so permit of conclusions for flat arches to be drawn which apply to the importance of skews or enlarged ends, which was never sufficiently appreciated, and it is probable that without the foregoing tests they would never have been considered anything other than a luxury to be indulged in only by a particularly careful engineer or contractor. Directions for the use of skews have never been published and their effect has never been properly considered.

The Problem of Skews.—To clear up this question the experiments described were undertaken by the Austrian committee for concrete-steel construction. The beams had skews of three sizes, 1/10, ⅛ and ¼ of the span. The smallest skews of 10 in. and only 8 in. height had a small effect and there was a weak point between the beam and the skew. The medium-sized skews 20/8 gave excellent results. The large skew 40/16 increases the carrying capacity to such an extent that the available load was not sufficient to secure the destruction of the beams. The effect of skews on arches would have to be ascertained by a similar tests, which would also show the dimensions to be chosen in order to obtain a definite result by a reduction of the span. At present it is necessary to rely mainly on guesswork. In the light of these facts it would have been better to provide the abutments of the Schwarzenberg bridge with stronger skews as shown in Fig. 11. The projection of these skews would, in accordance with the tests, be 51 : 17 = 3 yds. The change of moments causes an altered course of moments of inertia and brings about a large accumulation of moments of inertia so that the part, which in theory can be limited by a joint and which statically limits the center part of the arch, can be pushed farther out. It is thus made possible for an arch of 140 ft. clear span to have a bearing center of only about one-third, i. e., 50 ft. span.

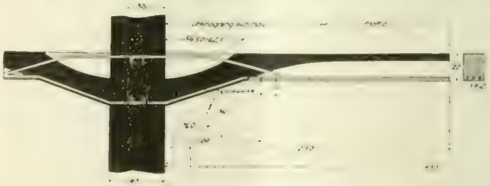


Fig. 9.—Mushroom Flooring.

Mesnager's Tests with Polarized Light.—Further support of this contention is found in the experiments carried out by M. Mesnager,* the manager of the experimental laboratory in Paris with a model in glass (Fig. 10) of a bridge designed by Hennebique over the Rhone near Balme with a 320 ft. span which was carried out in 1916 and which followed in form the Minneapolis bridge. In the glass model examined under polarized light by Mesnager, the course of the zero line was shown as a broad black strip which clearly marks the plates where a change took place and shows that the conditions in fixed arches are, throughout, similar to those of a fixed beam. By fixing an arch and by the use of skews at the point of fixation a reduction of the span of the carrying structure takes place which must necessarily be followed by a considerable increase in the carrying capacity of the arch, as was proved by the tests of the Austrian Committee on Concrete-Steel Construction.

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*Annales des Ponts et Chaussées, Paris, Vol. IV, 1913. An extract of this, by Dr. J. Polivka, was published in Beton und Eisen, 1917, page 103.

Under such conditions the actual carrying structure of the arch is confined to the center of the arch, and a connection exists between these consoles and the center arch acting in the same way as if a joint were placed there. The difference between a joint proper and this arrangement consists in the fact that with an actual joint the changes in form are concentrated in one point, whereas with the proposed arrangement the permanent changes of form of the concrete arch at the point can be utilized to distribute the necessary twisting tendency over a large portion of the arch.

The supposed free support, hinge or continuity with support on one point only, is not in accordance with the actual conditions with a concrete-steel structure because the connection of one span to the other or to the abutment does not depend only upon the elasticity or rigidity of the connection, but also upon the permanent change of form in the concrete. The axis of the structure at the points of greatest stresses has a broken form which is followed by a full change of its statics.

Attention may also be called to a further gap in our knowledge of reinforced concrete trusses, which is the reciprocal action of the permanent change of form of the concrete, and which is taken up by the steel rods. This supposed statical arrangement of joints by no means corresponds to the provisional joints mentioned earlier which have to be placed in closer proximity to the abutments, and can be closed up after all secondary tensions have ceased, and so have to be constructed sufficiently strong that this fixation is not interfered with.

Minor Importance of Live Load on Large Arches.—In considering the construction of arch hips and how they may be built so as to admit the use of wider spans, and thus to make a more extensive adoption of concrete arch bridges possible, it is necessary to keep in mind the fact that the deadweight of the bridge is the chief factor for the size of arches of large span, and the carried load is of such little importance that a change in it does not necessitate a complete reconstruction, as with steel bridges, but only a small and frequently quite insignificant extension of the permissible load. This is a fact of great importance, particularly for railways, as heavy arched bridges are specially suitable for rail traffic. In constructing a massive arch economically the chief task is to reduce as far as possible the deadweight of the permanent way and the supporting structure. For the latter it is well to choose a rib arch and to reduce the weight of the center of the arch as far as possible.

Straightening the Crown.—To provide a substitute for the crown joint it is necessary to construct the center of the arch on such slender lines that the reduction of the moments of inertia replaces a joint which would have to take up the changes of temperature. This requirement is in accordance with those of aesthetics which equally demand a slender construction in the center of the arch. This is made possible by constructing the center of a particularly resistant material for which there are three possibilities:

1. The use of cement of the best quality and well graded concrete of high strength.
2. The adoption of "hoopings" which give a high resistance to strains.
3. The use of cores of cast iron or stone of high resistance to pressure. Unfortunately these three aids cannot always be combined.

Tests have proved that if structures are made of different qualities of concrete, but with the same hooping, the effect of the latter will be enormous with poor concrete, and quickly diminish as the quality of the concrete improves. The effect of the hooping with concrete of the best quality is practically negligible. Tests published in Beton und Eisen, 1920, show that with a ½ per cent hooping an increase in breaking strain of 132 per cent was obtained, with an aggregate of 1,918 lb. per sq. in., but this increase only showed 38 per cent with a concrete of 3,052 lb. per sq. in. Hence, with concrete of 4,200 lb. per sq. in. crushing strength the increase resulting from the use of hooping would be less than 10 per cent which may, for practical purposes, be neglected. The use of a stronger hooping naturally makes it possible to further increase this difference, but a limit is soon reached in practice, so that the idea of providing large arch sections with hooping, and obtaining by these means a considerable increase of strength over and above the strength of best concrete is not worth consideration. Engineers have either to be satisfied with the high figures claimed for first-class concrete or and this appears to be the more reliable way—to increase the resistance of ordinary concrete by means of hooping. Such hooping requires an easily compressible concrete, because its effect only comes into play as a consequence of the compression, i. e., by the lateral expansion of the compressed body. First-class concrete is brittle, and it is not very suitable for hooping. No one can rightly deny the possibility of manufacturing concrete of the homogeneity required in building operations, but this is always a difficult matter. Moreover, the brittleness of the material is a weighty reason for its refusal. These qualities are a disadvantage chiefly in cases where the structure has to withstand certain changes of form, for instance, in house or factory construction, in mining work and in the erection of forts. It is, however, unavoidable in all cases of building construction, and in some it is helpful if the material adapts itself to a certain extent to taking up supplementary stresses.

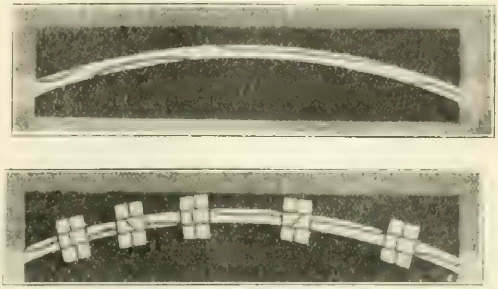


Fig. 10—Section and Plan of Glass Model Arch Bridge Viewed by Polarized Light.

The crown sections of the bridge in Treptow and of the Hindenburg bridge in Breslau in which wire hooped cores were used, were tested for crushing strength at the official testing institutes at Berlin and Dresden.

Column Tests of Crown Reinforcement.—Columns of 16 in. diameter and 6 ft. 8 in. length were tested in Dresden in the year 1916. One of the columns, made of concrete which had a strength of 1,554 lb. per sq. in. and without cast iron showed cracks at 175 tons pressure, and reached a breaking load of 188 tons, corresponding to an increase of resistance of 66 per cent. The same column with 10 per cent of cast iron showed fine cracks at 450 tons, and reached a limit load of 960 tons, under which it did not collapse, but only gave way gradually. This corresponds to a fivefold increase of carrying capacity, and a saving in deadweight of four times in comparison with a section reinforced with cast iron, and one with hooped concrete. The same results were shown by experiments with hooped stone core. Concrete of 3,178 lb. per sq. in. attained by means of the hooping 4,816 lb. per sq. in., or an increase of 38 per cent till the limit of load of 180 tons was reached. By inserting a 12 per cent stone section a load limit of 276 tons was obtained. Hence by means of the insertion of cores resisting high pressure it is possible to reduce the dimensions of the center arch considerably, and to decrease

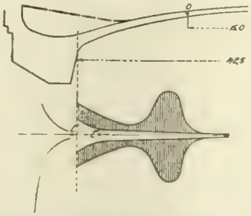


Fig. 11—Effect of Stronger Skew-Ends on Schwartzenberg Bridge.

its deadweight up to one-quarter, at the same time retaining the strength of the total section and the security against collapse.

Eccentric Loads.—Of still greater importance for arch construction are the tests made with eccentric loads which are comparatively rare. They enable the concrete force to act centrally upon part of the core, even if the ellipse is exceeded through the eccentricity. A column with 2½ in. eccentricity still showed a breaking load of 190 tons. The proportion of resistance to breaking load between a plainly hooped column and one with cores of high resistance cement is the same and exceeds it by more than five times. Hence such pressure-cores are particularly suitable for eccentric forces, and make it possible to leave a wider margin for placing the outermost pressure lines, and is the reason why eccentric tests conducted with crown sections of various bridges give such excellent results.

When an arch reinforced in the center with a cast iron core built of a concrete of about 2,800 lb. per sq. in. with a core of cast iron of about 112,000 lb. per sq. in. resistance to pressure, both held tightly together by means of the hooping, is considered the converting figure of 40 at the moment of rupture will result. This co-operation is arrived at in such a way that the modulus of elasticity first set in during the admissible loads in the proportion of 7.5 which then grows to 40 with the increasing load until the rupture. The whole range of temperature takes place exclusively within the limit of the admissible margin so that the figure 7.5 only comes into consideration for these increased temperature stresses, whereas for the safety of the building construction the further effect of the cast iron which is five times more is at disposal. Hence the crown of comparatively little stiffness only releases small effects of temperature and an arch with an arrangement of moments of inertia which acts similarly to a crown hinge with regard to temperature.

This point of view permits an economic form of the carrying structure of the arch and has been adopted on various bridges and extended to the designs of the abutments, although nearly all of them consisted of pile foundations. This is explained by the fact that the constructions so far completed nearly always had to compete against girder systems and were to be carried in a soil where no one had ever intended to erect an arch. Those cases which appeared suitable for arches were taken up at the outset by government or local men who relied upon the older proved methods without consideration of economy and technical advancement, and also upon the principle that an arch must be all the better the more ungainly it appears to the eye!

A Proposal That Encountered Difficulties.—The proposed bridge over the Arstabay was the subject of an important decision: the jury for the competition for a bridge design with an arch of 600 ft. span has freely acknowledged the technical uniform solution proposed on the lines mentioned above and has said distinctly that this one made the best general impression of all the designs submitted. Unfortunately it was not given the first place in other respects as well. On the basis of the given span the largest of which so far is 407 ft. it was said that a span of 600 ft. would represent too big an advance. Yet Professor Linton's design has an arch of only 320 ft. resting upon two consoles of 120 ft. each. It is, therefore, nothing extraordinary as the consoles have the character of supplementary abutments. Professor Linton has, in fact, done everything to meet such doubts apart from the fact that they would have no weight even if they were correct. This example shows how difficult it is for technical progress to go ahead when even so excellent a body of engineers considers itself under obligation to hamper the further development of arch construction, for by such a decision the erection of arched bridges is naturally confined to cases where the necessary height for construction is available. The arch is the economic solution wherever there is sufficient height, because steel girders cannot utilize such heights. The development of arch construction demands, however, the use of wide span and flat arches so as to reduce the construction height.

The foregoing proposition may be summarized by the following:

1. The construction should be made in the form of a two hinged arch with temporary joints for the purpose of taking up displacements in the form after striking centers.

2. The finished structure, however, should represent a fixed arch with wide reaching consoles so as to reduce the clear span of the arch proper as much as possible.

3. The arch proper is to be constructed of such slender dimensions with the aid of a hooped section and a core of high resistance that a minimum of deadweight and the least effect of changes of temperature is attained.

4. The centering of the arch must have the character of a proper erection scaffolding.

5. The abutments must be economically constructed.

If all these suggestions are carefully considered, there is no doubt that, with the present prices of steel, massive arch bridges will be utilized more and more for wide spans, as they adapt themselves to economic conditions, to the further development of concrete arches.

With the high cost of steel bridges the chief obstacle is removed, and it is to be hoped that in future the demand for architectural beauty in bridge construction will once more make itself felt. The fine carrying line of the fixed arch with its slender crown corresponds to our aesthetic feeling and satisfies both architects and engineers alike by the clear expression of its purpose. Bridges with an arch and suspended roadway cannot attain this ideal so readily though it can be done in a satisfactory manner.

A Remarkable Dredger

Four Bows and Six Suction Frames

From The London Times Supplement, March 18, 1922.

A dredger recently launched by Messrs. William Simons and Co., Renfrew, is of a new kind, and is believed to be unique among vessels of any kind. The vessel, named Ronaldshay, is of the cutter, suction-pump, reclamation type, and has been constructed for the Government of India for dredging the shallow rivers in the province of Bengal.

The principal and most peculiar feature is that there are four complete and distinct bows. In the three open wells formed by these bows are carried three suction frames, each of which has two suction orifices and two rotary cutters arranged to work in advance of the suction nozzles. There will, therefore, be six cutters disintegrating the clayey materials of the rivers and six suction nozzles drawing the materials up for discharge through a pipe line. Each pair of cutters is driven by bevel and spur gearing from an independent four-cylinder tandem compound engine. The suction frames are designed to dredge to a depth of 30 ft. under water, and are controlled by steam hoist gear and wire rope tackle, so that the frames may be raised or lowered independently or conjointly as required.

The two centrifugal pumps are each driven by an independent set of vertical triple-expansion engines, and the dredged materials will be discharged direct from the pumps through a floating pipe line 600 ft. in length and 42 in. in diameter. The pipe line will be raised by a terminal pontoon to a height of 25 ft. above water, level and the material will be finally discharged over the canal bank to a distance of 150 ft. from the centre of the terminal pontoon. The floating discharge pipe will consist of 12 circular pontoons, each carrying a 42 in. pipe 50 ft. in length, and all coupled together by special ball and socket connections. The vessel, which will dredge at one cutting a canal or channel 45 ft. in width at the bottom, has been specially designed for opening up new waterways and increasing the depth of shallow canals or rivers.

Broken Brick as Concrete Aggregate Resist Fire.—Concrete slabs composed mainly of broken bricks have come through severe fire tests successfully, a fact of interest to all concerned in concrete construction because broken bricks are cheap and, as a rule, easily obtainable. The broken brick, tested, consisted of broken brick in the following proportion: 37 per cent rubbish, 10 per cent flint, and 53 per cent of brick. This was picked over and an analysis of the material actually used gave 11 per cent of mortar, 11 per cent of flint pebbles, and 78 per cent of brick, the mix being as follows: Broken brick, 4; sand, 2; cement, 1. The slabs, generally speaking, were 5½ in. thick. It is pointed out that if broken old bricks are used it is essential that they should be thoroughly cleaned from all lime, mortar, and other rubbish.—Municipal Engineering and The Sanitary Record, London.

Color Light Signal Developments on British Railways

Committee Finds That Color Light Type with Separate Lenses for Each Color Indication Could be Arranged to Meet, as Far as Can Be Seen, All Conditions Now Covered by the Semaphore Type

From The Railway Engineer, London

On July 27, 1921, the Minister of Transport appointed a committee on Light Signals with the following terms of reference:

(i) To investigate the potentialities of light signals on British railways.

(ii) To examine light signals under trial, and recommend for further trial or scientific investigation any devices which are or may during investigation become available.

(iii) To form conclusions in regard to economies to be obtained at various locations, to draft outline specifications for design, to consider energy supply and to present a report.

The report of the Committee has recently been published and an important opinion is expressed as to the possibilities of color light signals. We reprint the report in full.

Report to the Minister of Transport.—In accordance with the directions contained in the minute of constitution the Committee have investigated the potentialities of light signals, and they have pleasure in reporting that definite and unanimous conclusions have been arrived at on this subject. It was realized from the outset that the subject must be regarded from two aspects, one being the broad question as to whether light signals, in some known form, could in general answer the purposes for which the semaphore form of signal is now used, and the other to ascertain the best and most suitable form or type of light signal now existent. In pursuing the subject it has been borne in mind that light signals as known today have not yet reached finality of design, and in putting forward their views the Committee have done so with the idea of helping progress in this important subject by making recommendations which are as elastic as possible. At the same time endeavor has been made to eliminate points which have been found unsatisfactory, and to prevent ground being retrodden which has already been explored and found unproductive of satisfactory results.

The Committee are indebted to the directors and the managing officers of the Liverpool Overhead Railway Company for the facilities given to inspect the color light signals installed on this line. The signals were seen during brilliant sunshine, and when the sun was immediately behind and also in front of the signals, and it was noted that signals over 1,000 yards distant were distinctly visible in these conditions. The Committee were also favored with an opportunity to inspect an experimental position light installation at Wimbledon (London & South Western Railway), the conditions as regards sunlight being the same as at Liverpool. The Committee was satisfied in each case that the degree of visibility of light signals in daylight was efficient, and would meet practical requirements.

Color Light and Position Light Signals.—The two main types of light signals at the present time are:

(a) Color light, in which indications are given by the use of the same colors as are employed today, viz., red, green and yellow.

(b) Position light, in which indications are given by a series of white lights which simulate by their arrangement the various positions taken up by a semaphore arm, viz., horizontal for danger, and inclined or vertical for warning or clear respectively.

The Committee is of the opinion that the color light type with separate lenses for each color indication offers marked advantages over the position light type on the one hand, and light signals with moving mechanism on the other; and that the first-named is the most suitable, and the most likely to commend itself for adoption on British railways, both from a practical point of view as well as being cheaper in first cost and maintenance. All further discussionss and recommendations deal, therefore, with the former color light type of signal. The Committee is also of opinion that this type of signal could be arranged to meet, as far as can be seen, all conditions now covered by the existing semaphore type.

The question of costs has been by no means an easy one In the first place, the Committee appreciates that comparisons are being made with costs of manual and power signal apparatus, which years of experience in competitive and bulk manufacture have reduced to a minimum, and on the other hand costs for light signals are being based on much shorter experience and on manufacture in small quantities, anyhow, in so far as this country is concerned; but it is anticipated that with further experience and manufacture in greater quantities the cost of the light signals can be considerably reduced in the future.

Comparative Installation Costs.—The Committee has been faced with the difficulty as to what would be fair comparative installations on which to base costs. In the case of a comparison between an isolated manually worked semaphore signal at 500 yards, and a color light signal at the same distance from the signal cabin, there is probably little difference in the costs of installation and maintenance. The determining factor in a comparison, however, is not the length of track equipped, but the density of signals per mile; and the greater this is, the greater the probable saving in favor of light signals. It should be observed, moreover, that the use of color light signals includes most, if not all, of the advantages obtained from power-worked semaphores (whether automatic or non-automatic) at a considerably lower cost. For the foregoing reasons, the Committee considers that the financial advantages to be obtained from color light signals apply more particularly to congested districts where power is available, and especially in large station yards and terminals; and that for sparsely signaled areas the advantages of the light signals can be obtained with little difference in cost as compared with mechanical semaphores.

Further economies will be obtained in that lighter and cheaper structures could be employed in the case of gantries and overhead bridges; dolls and post on such bridges would not be required; help weights and similar mechanical appliances for easing the signalman's work would be dispensed with; and, broadly speaking, the advantages of power-worked signals obtained at a lower cost. Signals could be mounted on simple posts in cuttings or confined locations, where, owing to insufficient space, an overchanging reversed type of bracket post would be required in the case of a semaphore arm. In many cases the height of signals, particularly on signal bridges and with bracket signals, could be 4 to 5 ft. less with the light signal, because the extra height which is now necessary for the operation of the semaphore arm in the lower quadrant could be dispensed with. Further economies in material and saving of effort could be obtained when dealing with slotted signals.

Fog Repeater Signals Might Be Abolished.—The obviously greater penetrative power of the light signal type of lamp, showing as it does a focused beam, makes it superior in fog to the long burning oil lamp in general use. This appears to offer economies by avoiding the use of fog repeater signals which might otherwise be necessary, under certain conditions.

The committee are of the opinion that a multiplicity of types and sizes of light signals should be avoided, and consider that three should be sufficient to cover all requirements, namely:

(a) Running signals—long range.
(b) Running signals—short range.
(c) Shunting signals.

In (a) the signal to be visible at a maximum distance of 800 yards in bright sunlight, assuming a 5 degree dispersion of the light beam. This condition can be met, at present, with a consumption of about 25 watts per signal lamp. With regard to (b) the committee consider that it would be preferable for the signal mechanism and case to be identical with (a), but that a smaller lamp (i. e., less candle power) should be used to suit local conditions. In the case of (c) the signal could be modified to the extent of a smaller lens, lower candle power lamps, and wider dispersion of the light beam.

In the case of conditions of curvature, etc., which affect the continuous sighting of the signal, the committee consider that any difficulties can be dealt with as they arise by increasing the candle power of the lamp, and the dispersion of the light beam. With regard to general visibility of the signals, the committee consider that it is necessary for the light beam to be so arranged that it will be in a driver's field of view from the sighting point to a point as close as possible to the signal itself. On gantries and bridges the height of the signals can be lower than with semaphore arms, the most suitable position being floor level, using if possible the gantry or bridge as a background.

A. C. Supply Recommended. With regard to the question of energy for source of light, the committee are of the opinion that electricity is the only practical and economical method of dealing with the matter. Alternating current supply offers great advantages over the direct current system, enabling power to be distributed more economically due to high voltage transmission and a low voltage supply to be given to the signal lamps by means of a simple transformer.

The committee wish to emphasize the necessity of using a lamp of the "focus" type, in order to procure the utmost efficiency of the light beam. These lamps are today more readily procurable for operation on low voltage.

The committee are of the opinion that power could be transmitted, using the ordinary telegraph and telephone pole lines, up to 250 volts with braided conductors, and 2,200 volts on a suspended cable. The committee are also of the opinion that the use of primary and secondary batteries is not an economical proposition for isolated signals, and that the chief advantage of secondary cells would be when used as a standby to the general power supply.

The absence of a standard frequency is to be deplored. The committee are of the opinion that frequencies of 25 and 60 cycles are the most suitable. Frequencies lower than 25 increase the cost of apparatus, and, above 60, the cost of energy. Any contact-making devices for completing circuits for operation of light signals as are now in use for power-operated signaling could be employed. The provision of artificial backgrounds does not appear to be necessary.

The committee point out that it will be necessary with this type of signal to resort to electrical means for detecting the signals through switch points in cases where such detection is required.

Indications of Signals.—With regard to the indication of the signals in the cabin, the committee recommend that this should be accomplished in such a manner that it proves that current is actually passing through the focus lamp in the signal, and also shows which particular lamp (red, green or yellow, as the case may be) is energized. It is considered that the lamp type of repeater is preferable to the instrument type for this purpose.

Having considered the question of drafting specifications for design, the committee are of opinion, for reasons already expressed in paragraph (2), that any specification should be as broad as possible, and, further, that any departure from this course would perhaps have a hampering rather than a helpful effect on this important question. The optical system is the most important factor in the design, and the committee limit themselves to observing, in this connection, that with the present state of knowledge, lenses alone offer certain advantages and appear preferable to reflectors or combinations of reflector and lens, as the production of phantom indication is less likely to occur with the lens alone. It is advisable to state that the trend of design must be to find a means of projecting in the beam the maximum percentage of the light supplied by the source of illumination, and it may be found that research into this question will produce methods whereby the maximum projection efficiency will be obtained by using other means in combination with the lens, without introducing the danger of phantoms, and also reducing the energy consumption of lamps which is required today.

The committee are of opinion that whatever form of lens is used in the outside of the lamp, it should have a smooth exterior surface, thus preventing the lodgment of snow or frozen matter. Lamp bulbs, sockets and caps of standard size should be used, the latter of the bayonet type, and to British Engineering Standards Association specifications. It is considered that the mounting of the lamps should include means for adjusting the lamp in all directions, in order to obtain accuracy of focus, with a device for locking it when in position.

Range of Visibility.—It is essential with this type of signal that if the focus lamp burns out or fails, the signal should not be entirely dead or dark, although it should be evident that the failure has occurred. This condition can be met by the provision of a standby lamp located in close proximity to the focus lamp, this standby lamp being energized on all occasions when the focus lamp should be alight. To eliminate as far as possible failure of both lamps, they should be run below their rated voltage. The range of visibility of the signal with the standby lamp burning alone should not be less than 40 per cent of the range given by the focus lamp, or 320 yards in bright sunlight.

As it is desirable that the number of contacts in any circuit should be reduced to a minimum, the committee suggest the consideration of some system whereby the circuit by which the red lamp is energized is never broken.

The committee consider that no special remarks are called for in connection with relays or similar devices, any of these which are suitable for power installation of a similar pressure being also suitable for light signals. With regard to transformers, the committee consider that these should, in all cases, comply with British Engineering Standards Association or Institute of Electrical Engineers specifications for insulation tests and rating. The committee are of the opinion that extensive hoods over the signal lamps are generally undesirable and are not required.

The committee point out that consideration should be given to the provision of some means of distinguishing between automatic and controlled signals, as is done in the case of semaphore arms.

Potentialities of Color Light Signals.—To summarize briefly the conclusions arrived at, the committee are of the opinion that the color light signal has potentialities which are worthy of the serious consideration of British railways. The chief advantages of light signals which this investigation has brought out are:

(a) They compare, at present, favorably in initial and maintenance costs with manual and power operated semaphores, and future development will doubtless allow this type of signal to show to further advantages in this direction.

(b) They make for other economies already enumerated.

(c) The same indication is given to drivers by night and by day, and always of a definite character.

(d) This type of signal is less prone than the semaphore to show a doubtful or wrong signal indication due to outside interference.

(e) They can be easily adapted to two or three positions, automatic, semi-automatic, and manual signaling.

(f) They are more easily controlled and slotted than the manual signals.

Injurious Action of Sulphur on Cement in the Tropics.—The earthenware pipes of the Colombo sewage system, laid down within the last fifteen years, are of the improved Stanford type joined by cement and sand in the proportion 1:1 with a waterproof ring of "galanack." This material is a mixture of sulphur, tar and oil, and has a crystalline structure and a biscuit fracture when fresh. In some of the older pipes, which had cracked, longitudinally and circumferentially, the cement had turned into a whitish putty, and the galanack had also altered. Examination of these products, according to Dr. Alexander Bruce, of the Laboratory, Colombo, in a recent issue of the Journal of the Society of Chemical Industry, shows that the sulphates had increased whilst the lime, iron, alumina and silica had decreased. The sulphur in the galanack had evidently been oxidized, and the sulphate had decomposed the cement, causing the pipes to crack. The humid heat had accelerated these changes; mineral samples containing pyrites have been observed to change into sulphate and sulphuric acid in the laboratory, where the temperature is 80 deg. F., while it rises to 90 deg. in the sewers.—Engineering, London.

Railway Electrification in South Africa. In connection with the electrification of the railways of the Union of South Africa, the Metropolitan-Vickers Electrical Co., Ltd., have received the order for the electric locomotives required for the first section of the line between Maritzburg and Glencoe, in Natal. The minimum number of locomotives covered by the order is 70, and the probable number 80, and the approximate value is about [illegible]. The locomotives will be built in England and are designed to operate with power at 3,000 volts direct current on the trolley wire. The electrification scheme has been prepared by the well-known consulting engineers, Messrs. Merz and McLellan, of London.—The Commonwealth Engineer, Sidney.

Railway Electrification in Italy

Direct Current Likely to Supersede Three Phase as Result of Trials Now in Progress

From The London Times Supplement March 15, 1922
(From an Engineering Correspondent.)

While electric traction in America and most European countries has almost always been carried out with either direct current or single-phase, the electrified Italian State Railways have presented the exception of being three-phase, and the adaptation of the three-phase induction motor to traction conditions must be regarded as a triumph for Italian engineers. It is interesting to note, however, that the claims of direct current traction are now being admitted, one of the reasons being the much smaller expenditure required for the single line of the overhead equipment and the reduced upkeep.

About a year ago a section of 27 miles of line between Turin and Ceres, with a maximum gradient of 3.5 per cent was electrified by the Italian Brown-Boveri Company, and the results of the operation of this experimental line have been very satisfactory. Power is bought from a company at 22,000 volts and 50 periods, and a single substation 12 miles from Turin feeds the whole line, with a maximum voltage drop of 15 per cent. The line voltage of 4,000 volts, much higher than the general practice in the United States or England, is obtained by means of two motor generator sets each consisting of a synchronous motor driving two dynamos, connected in series, of 2,000 volts each. The conversion sets are of 500 kw. and have an overload capacity of 30 per cent for half an hour, and 100 per cent for five minutes. The means adopted to overcome "flashover" in case of a short-circuit are worthy of note. The circuit breakers, instead of being instantaneous, are of the multiple break type, inserting resistance in the circuit at the same time and reducing the dynamo excitation. They are fitted with powerful magnetic blowout coils, and have given very satisfactory service.

The locomotives are of the double bogie type, each bogie having two motors mounted in the manner of tramway motors and permanently connected in series. Series-parallel control is then applicable to the two pairs of motors. The principal features of the locomotive are: Length between buffers, 42 ft.; gear ratio, 3.95; power, 550 h.p.; maximum speed, 25 miles an hour; drawbar pull, 10,200 lb., and weight, 41.5 tons. The main motors are of the enclosed, self-ventilating type, with four poles and interpoles.

The auxiliary machinery consists of two small 2,000-volt motors in series, driving a 12 kw. 110-volt dynamo, and also a fan to cool the starting resistances. The fan serves the purpose of preventing the racing of the set at reduced load. The 110-volt dynamo then operates the air-compressor set for the brakes. The controller is of the tramway type, but remote-controlled, and is fitted with special devices to reduce arcing. The speed controller is operated mechanically, but pneumatic control is used for the pantagraph collector, the main circuit breaker and that of the auxiliary set, the field-weakener, and the compressor.

The results olf the first six months' operations showed that the only weak point in the installation was the auxiliary set on the locomotive. The substation generators and locomotive motors have never flashed-over, and the few stoppages that have occurred were due to defective porcelain supports for the brush-holders.

"Simplex" Sewage Plants

Aeration Plant at Bury

From The Surveyor, London, April 21, 1922.

The Ames Crosta Sanitary Engineering Co., Ltd., 12 Victoria street, Nottingham, has installed under the name of "Simplex," numerous sewage purification plants similar to the one at Bury, shown in the accompanying illustration.

In the "Simplex" method of sewage purification by surface aëration the aims are: (1) Simplicity of motion, (2) economy in power, and (3) maximum purification.

"To activate the sludge," the firm point out, "it has been the custom to blow air under pressure into the sludge at the bottom of the tank. Experiments have proved that by this method there is a great waste of power, as 95 per cent of the air blown is used in agitating and circulating the sewage, and under 5 per cent for the aëration. In the "Simplex" process the agitation and exposure for aëration keep the liquid constantly agitated and on the move, and also supply it by surface aëration with the necessary amount of oxygen required for purification purposes. The tank is arranged with a conical bottom and a central tube coned at the lower end is fixed a few inches from the bottom of the tank, the top portion terminating in a dish the outer edge of which is raised about half an inch above the top water level. Inside the dish a revolving cone with suitably-formed vanes is suspended by means of a vertical shaft running on ball bearings rotated by shafting and bevel wheels. When the cone is in motion the liquid is thrown out in the form of a film wave, and the liquid and sludge then rise in the central tube to replace the liquid thrown out by the revolving cone. The vanes of the cone are arranged to throw the liquid off so as to strike the surface of the main volume of liquid in the tank in such a manner as to induce a circular motion which causes the liquid to sink in the form of a spiral to the bottom of the tank to be recirculated.

"Simplex" Process of Sewage Purification at Bury Works.

"To obtain the necessary amount of agitation and aëration the contents of the tank are circulated once in twenty minutes or three times an hour, the horsepower absorbed being about 12-hp. per twenty-four hours run per million gallons.

"The time taken for purification depends upon the strength and composition of the sewage and the standard of purification required, but as an example we may classify sewage into three grades of strength, as weak, medium, and strong, the time and power required for treatment would be:

Weak sewage, eight hours' treatment—4 hp. per million gallons.

Medium sewage, twelve hours' treatment—6 hp. per million gallons.

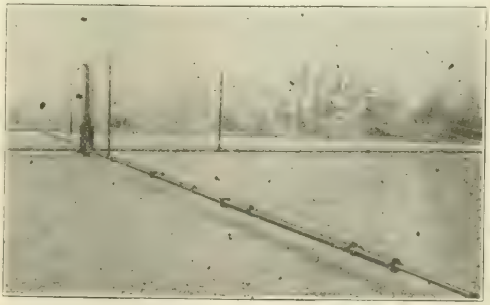
Strong sewage, sixteen hours' treatment—8 hp. per million gallons."

The firm claims that there is no process of sewage purification in operation which is so simple and economical which will produce any standard of purification required by the river inspectors and commissioners, and which can be so readily adapted to existing tanks or quickly installed in new tanks.

The Largest Sewage Sprinkler in the World

From Municipal Engineering and The Sanitary Record, London, April 20, 1922.

A rotary sprinkler of 180 ft. diameter recently installed at Chichester is believed to be the largest sprinkler in the world, supported and carried solely from the center pillar, and which will work satisfactorily with the low head of 3 in., thus demonstrating that these sprinklers are practically frictionless.


Rotary Sewage Sprinkler at Chichester.

French Rail Failures—Their Character and Causes

[illegible]

In Le Genie Civil for Nov. [illegible] is an article taken from a paper on rail failures by the eminent French investigator Charles Fremont who was urged to carry out this work because of the frequency of rail failures in France. It is estimated the number in France is 2,500 to 3,000 per year. Records show also the number to be increasing, on some systems such as the Midi and l'Est, at a rapid rate. The rapid corrosion of certain rails in tunnels he finds to be due to the presence of non-metallic inclusions in the steel. This corrosion is also a cause of rapid wearing away because it reduces the useful rolling surface.

Exfoliation of French rails is shown by the samples in Fig. 1, which exhibit this scaling in different degrees. At the beginning small longitudinal fissures are seen on the running surface. These fissures elongate and join. Often only one line is seen, as shown in the third sample, then later a second line at a distance usually of 1 or 2 cm. Sometimes these two lines appear at about the same time, the part between them is gradually detached, leaving a fissure which gradually increases and divides the head of the rail, as shown in Fig. 2.

The question arises whether the exterior fissures are the cause of the interior cavity or, on the other hand, whether the interior fissure is not formed first and finally reaches the surface. To determine this, cross sections show that wherever the exterior fissure is found, even when very small, an interior cavity is always present; and sometimes wide cavities are found, as shown in figure 3, which have not yet reached the surface. The beginning of such a defect is then always in the interior of the rail. In cases where not sufficient discard is taken the pipe is reduced to a fissure. Fig. 4 shows the section of such a rail in which this fissure, enlarged, has formed a blister in the web. In other cases the internal fissure, especially that in the head, does not come directly from the pipe cavity. After etching a section it is seen that the fissure passes through several nuclei of impurities. In this case the fissure is produced by the effects of shock from the passing trains. Mr. Fremont believes it comes from segregation of the metal and depends on the distribution and composition of this segregation.

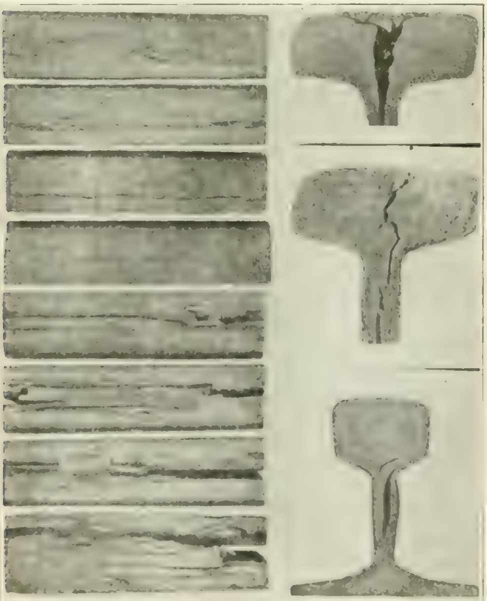


Fig. 1.—(Left) Exfoliation, or Scaling, of French Steel Rails.
Fig. 2.—(Top Right) Formation of Scaly Surface and Split Head.
Fig. 3.—(Middle Right) Large Interior Cavity in French Rail.
Fig. 4.—(Bottom Right) Blister from a Pipe.

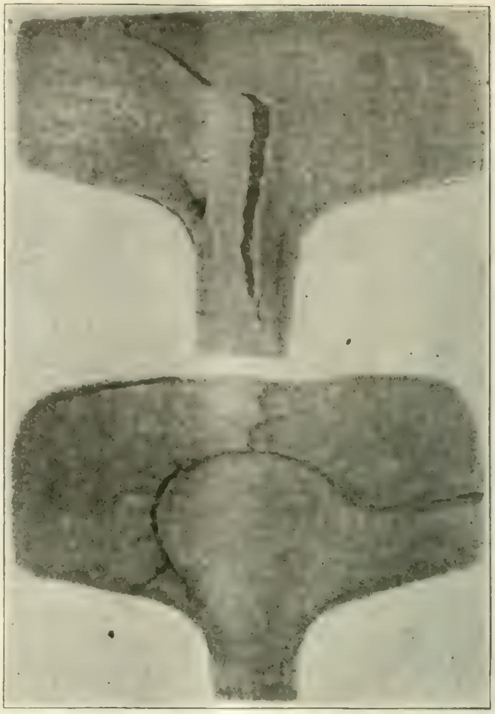


Fig. 5.—(Upper) A First Fissure at Central Nucleus.
Fig. 6.—(Lower) Fissure at Periphery of Central Zone.

The distribution of this segregation in the heads of the rails takes widely variable forms. Sometimes it is condensed in a central compact zone distinct from the sound metal. At other times the central zone is surrounded by nodules of small nuclei. It may be divided into secondary nuclei. Finally the heads of many rails are spoiled by the presence of a zone of blowholes parallel to and a little distance below the surface.

All these zones of impurities, almost concentric, are the cause of various defects. Figs. 5 and 6 give two examples of failure in which the influence of the central zone can be seen. Fig. 6 shows a central nucleus of good material, but surrounded by a segregated zone, from which emanate the radial fissures that are particular to this rail, and finally caused failure. Experimental tests would indicate that the fissures travel from one small nucleus of impure material to another.

After a further discussion of the matter Mr. Fremont believes the exfoliation or scaling of the rails to be due to bad initial quality of the steel, and not to fatigue of the metal brought about by cold work, as has been sometimes suggested. Careful tests with a specially designed hardness measuring device show that the cold worked material on the head only extends in 0.14 mm., and even with a softer rail the depth was only 0.23 mm.

The article closes with a description of superficial quenching of the metal of the rolling surface, as mentioned in a recent report by Mr. Howard, and the danger of the cracks in this hardened layer extending through the rail if the metal is not sound.

Formulae for Safe Load on Piles

By ERNEST LATHAM.

From Engineering, London.

The driving of piles in many cases forms one of the principle features of construction in marine works. In order to obtain the necessary data as regards foundations in the sea or river bed it is usual, in cases where there is any doubt, to have borings taken or test piles driven, or to observe both precautions. The writer places greater reliance on the results of test piles than on the results of borings in so far as actual ability of the ground to carry loads is concerned.

In driving test piles, very careful observation of the driving is necessary, as in driving from a "springy" stage or from floating craft, owing to the movement of the stage or the oscillation of the barge or pontoon, it is difficult to measure the actual penetration per blow which it is essential to observe closely when driving test piles from the moment when they begin to "pull up."

In driving permanent piles it is unfortunately necessary for practical reasons to average the penetration over a number of blows; this is common practice, but there are technical objections to it as if a pile has pulled up hard, this may obviously, have occurred on the first one or two of a series of blows and the balance of the series (before driving is stopped for the purpose of observation) may result in the destruction of the pile head or in certain cases, even in the destruction of the pile itself.

The data of which it is necessary to record in test pile driving is best shown by a record of actual driving which is given below for a single test pile driven through clay and peat with an ultimate "set" in Thames ballast.

RECORD OF TEST PILE (OREGON PINE, 14 IN. BY 14 IN.). GREENHITHE, JAN. 17, 1921.

No of Blows	Penetration. ft.	in.	No. of Blows.	Penetration. In.	No of Blows.	Penetration. In.
10	8	5½	10	1⅝	5	¾
10	4	9¾	10	1½	5	½
10	4	0¾	10	1½	5	7-16
10	3	4½	10	1⅜	5	½
10	2	6½	10	1¼	5	7-16
10	2	9⅛	5	½	5	½
10	1	9	5	⅜	5	⅝
10		5¼	5	½	5	½
10		3⅞	5	11-16	5	½
10		3⅜	5	1	5	7-16
10		3	5	¾	5	7-16
10		2½	5	¾	5	¾
10		2	5	11-16	5	11-16
10		2	5	⅞	5	⅝
10		2	5	¾	5	5-16
10		2	5	¾	5	5-16
10		1¾	5	¾	5	5-16
10		1¾	5	¾	1	1-16
10		1¾	5	1		

Length over all .... 53 ft. 6 in.
Level of pile head .... + 16.49 O.D.
Level of shoe .... — 37.01 O.D.
Penetration .... 42 ft. 6 in.
Level of ground .... + 5.50 O.D.
Final set (as above) .... 1-16 in.

The question of accurately determining the "set" for safe loads which permanent piles may be expected to carry has occupied the writer's attention for several years, mainly with the object of avoiding the technical objections of averaging the final set over a number of blows and the delay in stopping driving for the purpose of observation. As the result of experience in actual driving he prepared an empirical formula in 1914 and to this future contracts under his firm's jurisdiction have been satisfactorily carried out without failure in any case. This formula is dependent on a factor p, as given below:

Final "Set" of pile per blow.	Value of Factor p. Driving without Dolly.	Value of Factor p. Driving with Dolly.
Less than 1-16 in.	0.20	0.15
Less than 3-32 in.	0.15	0.12
Less than ⅛ in.	0.12	0.08
Less than 3-16 in.	0.10	0.07
Less than ¼ in.	0.09	0.06

The safe load is calculated as follows:

$$B = \frac{L}{p} \qquad (1)$$

where

L = safe load in tons.
p = factor as above
B = driving force of blow in tons calculated as follows:

$$B \times X = F \times T \qquad (2)$$

where X = penetration per blow in feet at or towards conclusion of driving.

F = fall of monkey in feet
T = weight of monkey in tons.

The British Steel Piling Co., who have a wide experience in pile driving, and no doubt working on similar lines, published in their handbook of 1921 a formula having a similar object.

Their formula is as follows:

$$L = \frac{2\,w\,h}{S} \quad 1 + \frac{W}{w} \qquad (3)$$

Where

L = safe load in pounds.
w = weight of monkey in pounds.
h = height of fall in feet.
S = penetration in inches per blow for the last few blows.
W = weight of pile in pounds.

In view of the fact that experience is the chief factor in specifying "set," one has to be very cautious in relying on any formulæ connecting "set" with safe loads. Except in exceptional cases, however, the first formulæ (equations 1 and 2) coupled with the correct value of the factor p may be taken as fairly reliable.

Another formula frequently adopted for lighter piles is the "Wellington" formula, as follows:

$$L = \frac{2\,w\,h}{S + C} \qquad (4)$$

C being a constant depending on the type of hammer used and frequency of the blows. This formula was recently applied by P. Allan in piling for wharves at Newcastle Harbor, New South Wales.

As the formula quoted by the British Steel Piling Co. was published at the time the writer was driving 70-ft. long timber piles in the Thames Estuary to a definite "set," he had the opportunity of applying both formulas with the following results. The actual loads which these piles were called upon to carry was 80 tons each, and they were driven into Thames ballast with a final specified "set" of 1-16 in. Applying the first formulæ (equations 1 and 2) the actual safe load worked out to 144 tons, and applying the second formula (equation 3) the actual safe load worked out to 153 tons. At first sight it appeared that the set originally specified had been more severe than was necessary, but it is as well to point out that, even where a factor of safety is already allowed for as in the above formulæ, a wide margin, where obtainable, should be adhered to, principally because so little of the theory of pile driving has yet been developed by civil engineers.

The Society of Engineers published a very useful paper by Mr. A. S. E. Ackermann, B.Sc., in 1919, entitled "Experiments with Clay in Its Relation to Piles." The paper is of great value from the theoretical point of view, and it throws a good deal of light on previously little understood phenomena. It suffers, however, from the following defects:

(a) The experiments are confined to those made with models.

(b) Loads were applied by continuous pressure and not by impact.

(c) The experiments were restricted to clay.

Briefly, in this and in a subsequent paper, Mr. Ackermann establishes the fact that at a critical pressure, varying with the nature and percentage moistness of the clay, the latter behaves physically as a liquid. This pressure he terms the "pressure of fluidity," and doubtless it explains the large amount of recoil shown by piles driven into London clay and similar foundations.

The formulæ quoted in this article must not be applied to quickly-operating single-acting steam or pneumatic hammers or to double-acting hammers of the McKiernan-Terry type.

New Material for the Manufacture of Roofing Tiles.—In several countries in Africa it has been suggested that roofing tiles should be made locally, and search has been made for suitable materials. Specimens of clay and sand, collected in Uganda, and of clay and diatomite from Kenya Colony, have recently been examined at the Imperial Institute in order to ascertain possibilities in this direction. The bulletin of the Imperial Institute states that tiles of good quality can be made with a suitable mixture of the clays and sand from Uganda, while good tiles can also be made from mixtures of the washed clays with "grog," i. e., clay which has been burnt and finely ground. The clays from Kenya Colony were also found to be suitable for making roofing tiles. The results obtained with the infusorial earth or diatomite (which contained a certain proportion of clay) are of special interest, as this material, which does not appear to have been employed previously for the purpose, furnished tiles which were much lighter than ordinary roofing tiles, this being a great advantage.—Engineering, London.

Tests on Sea-Water Corrosion of Structural Materials

From London Times Engineering Supplement.

An important part of the work of the committee appointed by the Institution of Civil Engineers six years ago to investigate the deterioration of structures exposed to sea action concerns the corrosion of structures involving the use of ferrous materials, and in a paper read before the institution Sir Robert Hadfield, who was consulted as to the most desirable materials for testing, described the various types he recommended for the purpose.

The materials he selected fall into four classes and comprise 14 different varieties. There are three rolled and forged irons (wrought iron, Swedish cast iron and Armco iron); four carbon steels (mild steel with low manganese and high sulphur and phosphorous mild steel with 0.70 per cent manganese, medium carbon steel with low sulphur and phosphorous, and carbon steel with 0.40 per cent of carbon); five special steels (mild steel with 0.50 per cent of copper, mild steel with 2.0 per cent of copper, 3.50 per cent nickel steel, 36.00 per cent nickel steel, and 13.50 per cent chromium steel, known as non-rusting steel); and two cast irons (cold blast and hot blast).

Preparation of Test Pieces. All the specimens, except those of cast iron, were prepared in the form of rolled bars, and in every case they are 24 in. long, 3 in. broad and ½ in. thick. Each of the materials was prepared in the condition "as rolled," that is, without further heat treatment, because it was thought best that the tests should be carried out on steel as nearly as possible resembling that met with in constructive work. In general also the oxide skin produced in rolling, or in the case of the cast iron, the casting skin was retained, but to obtain some information as to the effect of this skin in regard to corrosion, an additional set of specimens was prepared in the case of two of the carbon steels from which the skin was removed by grinding all over. Further, one of the bars of each material, except the cast irons, was heat treated to obtain test data representing the materials in the best possible condition.

In all, 1,330 separate specimens have been prepared, and 955 have already been allocated for test, the remainder being held in reserve. Of the 955 the majority are to be sent to various stations at home and abroad to be immersed in sea water, but 182 of them have been subjected to tests by Sir Robert Hadfield in his laboratory. These tests, the results of which are discussed in the paper, included analyses for all the elements present, tensile tests on test bars cut in the longitudinal direction, Fremont shock tests in both the longitudinal and the transverse directions, Izod shock tests in the longitudinal direction and Brinell hardness tests. Photomicrographs were taken in both the longitudinal and transverse directions, and in the case of a certain number of tensile test bars from the various specimens, detailed elongation figures were obtained, partly with the object of ascertaining the effect of strain on the corrodibility of the different types of material. Some data adduced for Armco iron show that the strained material is more subject to corrosion than the unstrained, and reasons are given for thinking that the resistance of non-rusting steel to corrosion when almost constantly wetted by sea spray depends on its physical constitution. One set of test bars is to be immersed in the sea at Plymouth to see whether the mechanical properties are impaired by long immersion.

The pieces that are to be exposed to sea action (at Plymouth, Auckland, Colombo and Halifax) include plain bars, riveted bars, bolted bars, bars of dissimilar material in contact and pieces bent to test the effects of strain. In view of the possibility of very severe corrosion in some instances, the marking of the bars presented a problem in itself, since there was a risk of any ordinary marking being obliterated and of badly corroded bars, or portions of them, falling out of place. The method finally adopted was to distinguish the bars by the number and position of holes drilled through their ends.

Cost of Waste by Corrosion. In the concluding part of the paper the author, after discussing different theories of corrosive action and the behavior of special materials, attempted an estimate of the waste caused by corrosion. Taking the world's output of iron and steel during 1860-1920 at 1,860 million tons, he estimated that 400,000,000 tons by 1920 had been discarded as worn out or useless and 660,000,000 tons lost by rusting in use, so that the quantity in use was 800,000,000 tons. In the same year he put the production at 66,000,000 tons, the quantity worn out or discarded as useless at 17,000,000 tons, and the quantity lost by rusting in use at 29,000,000 tons, so that the net increase of iron and steel in use was 20,000,000 tons. At £20 per ton the 29,000,000 tons lost by rusting in 1920 represented 580,000,000 sterling, and including the cost of zinc for galvanizing, of brass and other metals for sheathing or as substitutes for steel, and of paint for protection, he put the total cost of corrosion in that year at well over 700,000,000 pounds sterling.

Excavation by Water Jets in Finland

A process of winning peat which has been in operation at Jourikorpi, in Finland, since 1920 consists in excavating the peat in the bog by means of powerful jets of water, working it up into a homogeneous liquid mass, freed from the roots and stumps which form one of the obstacles to the employment of mechanical diggers, and then pumping it away to be dried.

For digging two water jets are employed, working under a pressure of 225 to 300 lb. per sq. in., and fed by two centrifugal pumps with an output of 75 cubic meters an hour. The jets, for which two attendants are required, cut off the outer layer of peat, which is often very tough, with the precision of a knife, and lay bare the stumps embedded in the peat so that they can be severed by a pair of shears incorporated in the pump, the jet being meantime directed to another point. The pumps together have a power demand of 125 hp.

The peat gathers as a thin, pulpy mass at the bottom of the pit in the bog, where mixing by means of the jet is continued in order to bring about the greatest degree of homogeneity possible. It is then sucked up by a turbine pump, having cutting blades adjusted to cause minute subdivision of the peat-mass. To protect the pump from the entrance of solid substances a propeller device is arranged at the inlet to throw aside any large object and by keeping the peat in incessant motion to prevent it from accumulating and blocking the orifice. It has also to pass a blade arrangement making over 4,000 cuts a minute. If, in spite of these precautions, any hard objects were drawn in they would cause the fracture of several safety bolts and the stoppage of the pump.

Above the turbine pump and on the same axle there is a powerful centrifugal pump which forces the peat-mass away through a pipeline to the drying area. The pumps with their driving motors are freely suspended from a crane arm mounted on a movable car, and they can be raised or lowered in accordance with the level of the peat in the bog. The output of the pump is estimated at 300 cubic meters an hour, but varies with the character of the peat. The power demand reaches 75 or 80 hp. As a rule two men are engaged in removing the stumps. In the movable car one mechanic performs all the operations necessary, including the starting and control of the peat pump, the manipulation of the crane, and the shears for cutting off the stumps, and the management of the motors for moving the car.

The pipeline is made up of sections four meters long, coupled together by a device which can be easily opened and closed. On the drying area the liquid peat is deposited in a thin layer, enclosed by a wall of peat, and when one section is full it is taken to another, lengths being added to or taken from the pipe for the purpose. Three men are needed for depositing the peat and shifting the pipe.

Apart from supervision, eight men in all are required to win the peat in this manner. The power-demand amounts to about 200 hp., and the quantity of water may rise to 150 cubic meters an hour, the same quantity of peat earth being obtained. In terms of dry combustible peat containing 25 per cent of water the output is 20 metric tons an hour.—London Times Engineering Supplement.

Loss on Trolley Omnibuses.—Keighley Town Council refused recently to pass the estimates for the trolley vehicle system. It is estimated that for 1922-23 the accounts will show a loss of £3,070, and it was recommended by a committee that the net deficit as at March 21, 1921, amounting to £5,321, be provided for out of the rates.—The Surveyor, London.

An English View of the Disadvantages of High Buildings

From The Surveyor, London, March 10, 1922.

The Town Planning Institute have had under consideration proposals which have been made in reference to the height of buildings in London and the relaxation of restrictions on such height, as at present administered by the London County Council. Particular attention has been given to the experience gained in regard to this subject in American cities, where the greatest use has been made of unrestricted opportunities to erect high buildings, both for residential and commercial purposes, and some notes upon this experience are attached.

It may be remarked that the agitation in London for the relaxation of restriction on the heights of buildings comes at a time when a number of American cities have found it necessary to impose, and many others contemplate imposing, restrictions as drastic as possible in view of what has already been permitted. Anybody who knows the objection of the American citizen to any regulations limiting his freedom to build as he likes will realize how generally recognized and how serious must have been the evils springing from the absence of such restrictions before their adoption could have been carried by general consent. It must be recognized, moreover, that in the majority of American cities the conditions are such that the evils arising from excessively high buildings are much less apparent than they would be in London; the streets and the footways are generally much wider and capable of dealing with a greater volume of traffic, and the atmosphere is clearer. On Manhattan Island, which forms the central area of New York, there are eleven "avenues" running from one end of the island to the other each 100 ft. wide, and the latitude of the city is the same as that of Rome or Constantinople, so that the sun attains a higher average altitude, and consequently its rays have greater opportunity to penetrate into narrow streets or spaces; there is also greater intensity of light.

Institute's Conclusions.—The Town Planning Institute have arrived at the following general conclusions on the matter:

(1) In considering restrictions on the height of buildings in London, full account should be taken of the climatic conditions there prevalent, of the winter height of the sun, the general intensity of light, the prevalence of mist, and the humidity of the atmosphere. They should also be considered in reference to the general width and direction of existing streets; to the policy that is likely to be adopted in the future in regard to the development of Greater London and its outer regional area; to the existing congestion of traffic, and to the practicability of providing increased transport facilities; and, in particular, regard should be had to the effect of any proposals on the general health and well-being of the occupants and users of the buildings, and the convenience of the public generally.

(2) It is clear that an increase in the height of buildings must add to any existing congestion of traffic and must throw a greater strain upon all public services. The volume both of pedestrian and vehicular traffic must be greater, and the capacity of drainage, water supply, and other conduits may need to be increased, as well as the public transport services, both for passengers and goods.

(3) Experience shows that it is extremely difficult to secure adequate circulation of air and sufficient light to the lower rooms where high buildings are adopted. It is common experience that in American cities a vastly greater proportion of rooms, both those in tenement dwellings and those in business premises, require artificial light to be burned throughout the day than is the case in London. So important is this effect in America that frequently a high building standing alone and benefiting by the light over the area of adjacent property is so seriously depreciated in value when the adjacent owners also increase the height of their buildings that the rent received falls to little more than enough to pay the local rates.

(4) It is by no means clear that the concentration of increasing volumes of retail trade in a few centralized establishments, or the concentration of general commerce on more restricted areas, which is the chief reason for the demand for increased height of buildings, is itself generally desirable in the public interest. In a city like New York, where the central area consists of an island surrounded by wide rivers, reasons of economic necessity may exist which are quite absent in the case of most towns, like London, where there is an unlimited area over which expansion can take place; and in view of the serious disadvantages arising from development by increased height, it is considered that some overwhelming public advantage and not merely a benefit to a limited number of prosperous businesses would need to be established to justify the relaxation of existing regulations, and the institute are of opinion that no such general public advantage has been established.

(5) It is, of course, recognized that there may be situations so advantageously placed as regards open space about them, and so well served by existing roads and other services, that in these cases a reasonable increase of height might be permitted without public disadvantage. The institute are of opinion, however, that it is not possible to provide for anything further than the existing discretionary powers of the London County Council without incurring great danger, unless and until a comprehensive plan for dealing with building development and traffic problems throughout the whole of London is prepared; and that any such exceptional increase should then only be allowed in the case of specific sites fixed upon such a plan, agreed with owners, generally conforming with the requirements of comprehensive planning, and subject to special rating to compensate upon all public services.

Recommendations.—The institute therefore recommended:

(1) That no relaxation at present be made in the regulations dealing with the height of buildings.

(2) That so soon as the form of the future government of Greater London, now under consideration, has been determined, a development plan of the whole of the area should be prepared, and zoning regulations on the lines of those recently enacted for the city of New York, but adapted to the special conditions prevailing in London, should be framed and given effect to. These regulations would deal with the height, density, use and character of buildings generally, and the zoning plan could provide for those exceptional sites, if any, where some increase of the general limit of height could wisely be permitted.

American Experience in Regard to High Building.—Consideration has been given to the conditions in American towns where an unrestricted limitation as to height has obtained, and more particularly to the report which has recently been made in New York by a commission charged with the duty of investigating existing conditions and of drafting regulations as to restrictions. The committee consisted of representatives of the different boroughs, who were assisted by a technical staff. The final report of this commission was submitted on Dec- 23, 1913, and, after holding a series of public hearings resulting in certain modifications, was finally approved in the year 1916.

In considering this report in its reference to the requirements of London, the Town Planning Institute have had in mind the peculiar conditions of New York as regards its wider streets and intenser light. The subsoil of London for the foundations of high buildings is in no way so suitable as is the solid rock upon which the city of New York rests, and not only is the question of cost of foundation one to be considered in the erection of such heavy buildings, but there is also the question of interference with existing drainage schemes and disturbance to buildings on adjacent sites.

Even having regard to these natural advantages for the erection of high buildings in New York, the report referred to states that: "There is an intimate and necessary relation between conservation of property values as here proposed, and the conservation of public health, safety and general welfare; throughout the city the areas in which values have been depressed by the invasion of inappropriate uses or lack of building control as to height, courts and open spaces, are the areas in which the worst conditions as to sanitation and safety prevail and where there is the greatest violation of the things essential to public comfort, convenience and order."

Another point that is brought out in the report is that, after high buildings are erected in sufficient number so as to prevent adequate light and air being obtained for each building, they do not pay.

One of the elements which prevent high buildings from paying is the great cost of providing lifts and the great area of the most valuable floor space taken up by the lift service. It is claimed by authorities that it takes three times the lift capacity in car mileage for the second flight of 10 storys as for the first flight of 10 storys.

Proof of the business argument against high buildings as unremunerative is shown by the fact that the merchants of Fifth Avenue unanimously requested a limitation of height to one and a fourth the width of a street, the maximum height permitted to be fixed by the ordinance governing the matter.

In those cases where high buildings pay they have to borrow their light and air from adjacent property. So long as they are isolated they have a comparatively high rental value, but they destroy the light and air of the lower buildings surrounding them. One high building may depreciate the adjoining properties to a serious extent.

And it has been shown that the worst feature of high buildings is that while they prevent the free circulation of air, obstruct light and cause congestion, at the same time they do not pay; they cause great loss to the community in having to deal with the serious traffic problems they create and the strain they cause to public services. That a great increase in the congestion of traffic would follow an increase of height of buildings is clear to anyone who has been in an American city among the high business buildings when work commences in the morning, at the lunch hour, or during the time when the occupants are leaving work for home. As New York is on an island, London is much better off in its opportunities for developing laterally.

German Colorings for Cement

The production of colored articles in cement mortar or concrete has always been somewhat unsatisfactory, and many façades which had a pleasing appearance when new have rapidly deteriorated and become unsightly. This applies especially to concrete tiles.

Reds.—The best red colors are produced by red bole, a natural oxide of iron whose tint has been developed by levigation and calcination. It is largely used as the basis of red oxide paints.

Several varieties of iron oxide are available, they vary considerably in composition, according to the amount of combined water present. The color does not appear to be directly related to the chemical composition, but rather to the size and density of the particles.

One of the best forms is a by-product in the manufacture of sulphuric acid from calcined pyrites, but for use with cement it should be free from sulphurous acid, which is a common cause of scum and discoloration.

Yellows.—Ochre is the chief material used for the production of a yellow color in cement work. It is a weathering product of ferruginous felspar and of very variable composition. It is usually kept for several years in the open, then ground and levigated so as to separate coarse impurities. Umber is a darker color, but in many respects similar to ochre. Both ochre and umber reduce the strength of the cement mortar or concrete.

Zinc yellow (zinc chromate) is sometimes used as a yellow pigment, but its price is generally too high for its extensive use in concrete or cement work.

Blacks.—There are two chief sources of black pigment suitable for use with cement, namely manganese black and carbon black. Manganese blacks consist chiefly of manganese dioxide, while carbon blacks consist of slate, black shale or some kind of soot, such as lamp black.

[illegible] is also largely used as a black pigment. All these pigments must be particularly finely ground. Usually manganese black is more serviceable than carbon black, but [illegible].

Greens and blues are made from ultramarine with some other pigment, such as chromium oxide. Ultramarine increases the strength of the cement on account of the free (colloidal) silica and aluminate present which gives it hydraulic properties.

The best green pigment for cement mortar is chromium oxide prepared from a mixture of potassium bichromate and sulphur. It should be bought as its preparation is difficult.

Lime green is a [illegible] alumina silicate, containing some iron and of a very variable composition. Most green cement mortars or concrete fade on account of the [illegible] of the free pigment.—Zement. Translated in Concrete and Constructional Engineering, London.

The Engineer as a Business Man

Editorial in Municipal Engineering and The Sanitary Record, May 4, 1922.

Some very pertinent observations were made recently by Mr. R. C. Harris, Commissioner of Works, Toronto, in his address on the subject of "Engineering Education" to the student members of the Engineering Society of the University of Toronto. The engineer, he said, comes from the University essentially a builder and feels it his duty to design, draft, and build, but he rarely has a proper conception of engineering in relation to business. He is a trustee of the health and comfort of the community and, to some extent, the public's banker. To him are entrusted the problems of securing pure water, proper sewage, clean air, etc., yet it is said the engineer is not a good administrator. That fault lies not so much with the individual as with the system. He has ability for administrating, he has analytical ability, and has been taught to think properly. He designs and visualises the finished product, but how often does he relate the design to the economic factor? The engineer requires essentially to be a man of courage, a man with a vision to look into the future and design his work with the assurance that he is right and that the future will demonstrate the reasonableness, the safety and the usefulness of his work. He must be ready to branch out and not hesitate because the thing has not been done before. The engineer, again, should have the courage to protect his client, to give him that which is required rather than that which is desired; and while protecting his client against himself he must at the same time protect his own reputation. In the end it is the engineer who must bear the censure if any mistakes are made. Many men are failures as engineers because they lack initiative; they do not do the proper thing at the proper time, but are content to travel along the beaten path, content to follow the lead of others. Do not be afraid to reach out; the man who does so will make mistakes—every man does—but a mistake is of infinite value when it is a lesson. An engineer's training should equip him with the capacity to handle emergencies, for the life of an engineer is practically one long emergency. Instead of associating wholly with his professional brethren, he should go out into the world and meet business men in various branches of industry so that he may get some of their perspective and absorb some of their vision and view points.

American Engineering Advertisers to Meet at Milwaukee June 12 and 13 in The First National Industrial Advertising Conference.

The program and exhibits of this conference are being planned to afford the largest possible interest and value to industrial advertisers. The conference forms the central feature of the A. A. C. of W. convention which meets at Milwaukee June 11 to 15.

Industrial sessions will be held on the afternoon of June 12, and on both morning and afternoon of June 13.

Keith J. Evans, Engineering Advertisers' Assn., Chicago, Adv. Mgr. Jos. T. Ryerson & Son, 16th and Rockwell, Chicago, is chairman of the conference, and Russell T. Gray, 616 South Michigan Ave., Chicago, is chairman of the exhibit committee. Screens 3 ft. by 6 ft. are to be used and the cost (to cover expense only) is $4.00 per running foot (6 sq. ft.) of display space. The members of the Engineering Advertising Association are underwriting the expense as payments to the General Exhibit Committee of the A. A. C. of W. must be made in advance.

If you desire a hotel reservation, write or wire Mr. H. I. Delander, Crane Company, 836 S. Michigan, Chicago.

Roads and Streets Monthly Issue

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Quarries and Pits
(c) Streets
(d) Street Cleaning

Waterworks and Hydraulics—2nd Wednesday
(a) Water Works
(b) Irrigation and Drainage
(c) Sewers and Sanitation
(d) Waterways
(e) Quarries and Pits for Ballast and Concrete

Railways—3rd Wednesday
(a) Steam Railway Construction and Maintenance
(b) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(d) Miscellaneous Structures
(c) Harbor Structures

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How Dishonest Retailing Is Being Overcome by Trade Marking

The Supreme Court has just rendered a decision that apparently is a big step forward toward the goal of honest merchandising. The decision virtually overthrows the old common law principle of "letting the buyer beware," and makes it illegal to deceive the buyer by the use of misleading or untrue designations of products. Hitherto it has not been illegal to call a cloth "woolen" even though it were 90 per cent cotton, but hereafter, as we understand the decision, such practices will be at the seller's rather than the buyer's peril.

For many centuries trade marks have existed, but only within a hundred years have the courts recognized them as legal property. Indeed, it was but 50 years ago that America and England passed laws providing for the registration of trade marks.

The oldest trade mark of which we recall mention is the word "Sterling." Its origin is disputed, but the word is commonly supposed to have been first applied to silver coins issued by a group of merchants in eastern Germany, who were known as Easterlings or "Sterlings." Be the origin what it may, the word sterling as applied to silver money or silver ware, came to signify a certain standard of purity as early as the year 1100 A. D.

During the past half century manufacturers and wholesalers have increasingly endeavored to mark or brand their products so that the retail buyer may know exactly what he is buying. Many difficulties have had to be overcome in accomplishing this end, particularly in those lines where the goods are not retailed in containers or packages. How, for example, can apples or oranges be so marked as to indicate who has grown them? A label pasting machine has been invented to paste labels on fruits so effectively that the label will adhere through all vicissitudes of transportation and handling. A certain hotel that grows its own apples pastes a paper stencil on each apple before it has ripened, and the sun photographs the hotel's name on the apple skin. Even the problem of labeling fish seems to have been solved by the San Juan Fishing and Packing Company, by fastening with pins a label to each kippered salmon.

"Sealshipt" oysters were forced out of the market as such because it was impracticable to prevent substitutions of inferior oysters.

For several years certain manufacturers of wire rope have trademarked their rope by weaving a colored strand through the rope. Now comes a manufacturer, the Williamsport Wire Rope Co., with an excellent extension of this idea. This company makes six different grades of wire rope for different purposes. Accordingly it weaves a special tape through each rope. On the tape is the name "Williamsport," and the kind of the wire: (1) Improved Plow Steel, (2) Plow Steel, (3) Extra Strong C. C. Steel Mild Plow, (4) Crucible Cast Steel, (5) Mild Steel Elevator, (6) Iron. Six different colors of ink are used in printing the six different "Telfax tape markers."

By this innovation the buyer is able not only to identify the manufacturer but also to identify the grade of steel that the rope contains. A tricky retail dealer can not substitute one grade of this rope for another without risk of immediate detection.

Little by little the ingenuity of manufacturers and their sales managers will probably overcome all the difficulties inherent in assuring the retail buyer that he is getting the exact grade and make of article that he wants.

In this connection, the editor recalls a recent conversation with a building contractor who said that three out of four retail lumber dealers are so dishonest that he could not rely upon them to deliver the grade of lumber ordered. Probably it is the general existence of such dishonesty that has led to the recent agitation in favor of grade marking every stick of lumber at the mill.

The Absurdity of a "Fourth Dimension of Space"

By HALBERT P. GILLETTE, Editor

[illegible] mathematics is still encumbered with several [illegible] [illegible], some of the most absurd of which flow from the assumption that it is possible to reason about inconceivable things. For example infinity is often defined as an inconceivably great quantity, than which I know nothing more absurd unless it is the definition of a line as something that has length but no width or thickness.

[illegible] as are such definitions, they are logically absurd. [illegible], it will be asked, how comes it that geometry and calculus are worth while systems of thought if they are founded on absurd definitions? The answer is that although the verbal definitions of lines and infinitesimals are false, the real definitions are true. A physical line—and we know no other—always has thickness.

An infinite quantity is not inconceivably great, but is as great as you care to conceive it. An infinitesimal is as small as you care to conceive it. The integral sign indicates the infinite quantity (thus defined) and the infinitesimal sign is its reciprocal, whence it follows that the integral of the infinitesimal is the unit quantity under consideration.

It is often said that very great quantities are inconceivable. But ask yourself what is the process of conception. It is a mental picturing, if the thing is visual. Very well, [illegible] a trip from New York to San Francisco. Necessarily the mental picture is a moving picture, not an instantaneous picture. So it is with conceiving great numbers; we picture them by successive steps of addition or multiplication, each step being readily visualized. It is just as absurd to ask you to conceive a million at one stroke, as to ask you to conceive a trip across America at one stroke. Very great numbers and very small numbers are conceivable, the one class by successive additions or multiplications, the other class by successive subtractions or divisions.

Writers about Einstein's theory of relativity have usually attempted to explain time as being a fourth dimension of space. The average man instinctively resists such an explanation, for he can not conceive a fourth dimension of space. But he is usually silenced by the assertion that it is not necessary to conceive a thing in order to reason about it, and certain examples of alleged reasoning about inconceivables are cited. I have just indicated that such examples are illusory, either because they involve false verbal definitions, or because they involve a false conception of the process of conception. Let us now consider how it came about that a fourth variable (time) in Einstein's formulas was illogically taken to mean a fourth dimension of space.

Copper, tin and zinc are three metals that are used to make alloys. If the percentages of each of the three metals are varied, the tensile strength of the resulting alloy will vary. The percentages of the three metals are three variables, and the strength of the alloy is a fourth (dependent) variable. Each of these four quantities can be platted on a [illegible] ruled chart, using dimensions to indicate their relative magnitudes, but it does not follow that the tensile strength is a fourth dimension of space. It is merely a fourth variable, although it may be graphically illustrated dimensionally. Precisely the same holds true of the fourth variable in the Einstein formulas; it is no more a fourth dimension of space than is the tensile strength of an alloy of three metals. Space or distance is a variable in the Einstein formulas. Since spatial relations are [illegible] by three planes perpendicular to one another, and since time can also be [illegible] as a [illegible], there may arise an appearance of [illegible] a fourth dimension of space, although in fact all that is [illegible] is a fourth variable that is quantitatively [illegible] by one of the three space dimensions. The error in calling time a fourth dimension of space springs from confusing the [illegible] attributes of [illegible] with the attributes of the variable that is charted. Exactly the same sort of error would occur if the tensile strength of an alloy of three metals were called a fourth dimension of space, because it is platted as a dimension, length, in a series of [illegible].

Einstein's formulas, [illegible] [illegible], were [illegible] with, and had nothing to do with the assumption that time is a fourth dimension of [illegible] [illegible] [illegible]. Sometime after the publication of Einstein's original relativity theory of time and space, it was pointed out by Minkowski that what Einstein had really done was to treat time as the fourth dimension. Writers who are unaware of this fact are apt to think that a confirmation of Einstein's formulas confirms the theory of time as a fourth dimension of space, for they mistakenly assume that Einstein's deductions were based on the fourth-dimension hypothesis, whereas they were not.

Einsteinists have frequently used the illustration of imaginary two-dimensional creatures that could not conceive a third dimension, and have tried by analogy to indicate that although we three-dimensional creatures can not conceive a fourth dimension, still it may exist. But they do not carry their analogy to any useful conclusion, for to be applicable they should show that some two-dimensional creature has reasoned effectively about a third dimension, even though he could not conceive it.

I need not dwell on the absurdities involved in the alleged conception of two-dimensional creatures, for it would be obvious that this is one of those pseudo-conceptions that loose philosophical thinkers [illegible] in. Let them tell us exactly how they mentally picture a two-dimensional creature as capable of perceiving and reasoning. If it cannot move it can not measure distance, and consequently can not reason quantitatively about either of the two dimensions that compass it. Let them tell us how such a creature would see, or hear, or taste, or sense in any manner any thing. Devoid of thickness it would have no mass and would neither convey nor transform energy. The truth is that a two-dimensional creature is exactly as absurd as Euclid's definition of a point, a line or a surface. It defies all attempt to conceive it. Being inconceivable we can affirm nothing about it except its inconceivability. To use an inconceivable thing as an illustration or example of how we may conceive a fourth dimension is the acme of asinine reasoning.

An Analysis of Government Expenses for 1922

It is astonishing to learn that almost three-fourths of the federal government expenses for 1922 are of a military nature, and that if we exclude the post office, which is almost self supporting, the total expenses for non-military purposes are only one-sixth of the expenses for military purposes.

The following table gives the expense budgets for 1922 in millions of dollars:

Roads	$105
Other public works	27
Department of Agriculture	18
Interior Department	[illegible]
Department of Commerce	20
Other departments and [illegible]	219
Total	$453
Post office (nearly self supporting)	576
Total non-military expenses	$1,029
Army	$306
Navy	423
Shipping Board	50
Veterans of World War	386
Veterans of other wars	252
Interest on debt	951
Sinking fund on debt	284
Miscellaneous military	120
Total military expenses	$2,772
Grand total	$3,801

It will be noted that $638,000,000 is the estimated expenditure in behalf of war veterans, or 40 per cent more than all the non-military expenses exclusive of the post office, and almost as much as the combined expenses of the army and navy.

Sinking fund expenses to retire war debts, total $284,000,000 or 60 per cent of all non-military expenses other than postal expenses. The question arises whether it would not be wiser to defer reducing the national debt. Since national credit would not be impaired by refunding debts as they mature, it would seem wise to defer reducing them. A financially strong nation differs from an individual or a stock company in that it can always refund its debts, and therefore need not take the precaution that an individual or company should take. Most companies refund their bonded debts time after time. Then why should not our government refund its debts, and then lower the oppressive burden of taxation?

The Progress of Socialism in Australia

Ten years ago much was heard of socialistic government in Australia, and of the promising future of that country under the rule of the "working classes." We are now beginning to hear that the experiments have not turned out very well. In our Foreign Review Issue last week we quoted an editorial article in The Commonwealth Engineer on "Labor Unionism in Australia to the effect that Australian "towns are under-industrialized and country districts are undercultivated." When it is realized that in Australia the labor party has been dominant, and that labor union socialism has had full play for many years, it is difficult to avoid the inference that majority control of the minority in industrial matters is not conducive to prolonged progress.

The majority, be it remembered, is usually quite as selfish as the minority, and a good deal more shortsighted. A selfish minority of capitalistic leaders might block progress quite as effectively as a selfish majority of socialists or unionists, and probably would do so were it not that competition among capitalistic leaders puts a pretty effective curb upon their selfishness. They compete among themselves to hire mental and manual workers. This competition stimulates both employer and employee to increase his output in order to increase his personal income. Selfishness is thus made to act so as to aid economic progress rather than to retard it.

Eleven per cent of all adults in Australia are on the Government payroll, as contrasted with less than two per cent in America. Bearing upon this condition we quote the following from the London Times:

Mr. J. D. Gordon, president of the Associated Chambers of Commerce of Australia, in his address to the 18th Congress of Chambers at Hobart a month ago, pointed out the exact sequence of events. Mr. Gordon expressed the opinion that many of the financial difficulties were self-imposed and attacked the excessive legislative interference with business which had been indulged in by the Commonwealth with disatrous consequences to the public finances. He mentioned that one adult in nine is on a Government payroll, and added: "The Government is always a bad trader and a poor employer, and it is a matter for amazement that there should be any person still so impoverished in ideas, so lacking in political sanity, as to be still prepared to advocate Government ownership and control." Such an expression from a prominent business man of a country in which Government ownership has had every advantage and opportunity, serves to drive home the lesson which the people of these islands have learned at such a heavy cost to their pockets during recent years.

The President Offers Congratulations on Success of the Unemployment Campaign

President Harding has written to Secretary Hoover to express his gratitude for what was accomplished during the past winter and spring in relieving unemployment. While the President's references are directed chiefly to the Unemployment Conference and its committees, all public officials and private individuals who put forth their efforts in this cause may fairly accept a measure of the praise as their own, and may justly take pride and satisfaction in the accomplishments. The President's letter, which bears date of May 22, follows:

My Dear Mr. Secretary:

Now that the revival of employment through the country—except for the strikes—has so greatly improved our situation that our anxieties in this particular are largely removed, I wish to extend my gratitude to every one of the great body of our citizens who gave such efficient service in the organizations set up and co-ordinated under the Unemployment Conference of last autumn. The conference members and its standing committees deserve great credit for the successful inauguration and stimulation of the great simultaneous movement in the community, and its continuing organization, which has so greatly succeeded in the mitigation of what otherwise would have been great suffering.

We have passed the winter of the greatest unemployment in the history of our country. Through the fine co-ordination and co-operation among federal and state officials, mayors and their committees of employers, relief organizations and citizens, we have come through with much less suffering than in previous years, when unemployment was very much less. So much has this been the case that except for the intensification of public works by the federal, state and municipal governments, the demand for aid to the unemployed from the federal treasury disappeared in the country. Only two or three of our large cities failed to secure co-operation to the best advantage.

For this inspiration, organization and co-ordination of the community, and for the forces making for common action, the Unemployment Conference and its standing committees deserve great credit for a work quietly and efficiently carried out.

In this note of appreciation I wish to include the Secretary of Labor and Colonel Arthur Woods, the director of the work.

Yours faithfully,

WARREN G. HARDING

Invitation to First Meeting of American Construction Council

Lacking facilities at present for direct communication with the thousands of important men in the construction industry, the temporary directing committee of the American Construction Council begs leave, through the columns of the engineering, architectural and construction press to extend a personal invitation to each member of the industry to attend the organizing meeting in Washington, D. C., June 19 and 20.

The step contemplated, that of bringing together for co-operation in behalf of the industry and of the public all the elements of construction activity—engineers, architects, labor, the contractors, the manufacturers and dealers, and the financial interests—is epochal in American industry. It deserves, and promises to have, the full support of the entire industry. A full representation at the organizing meeting will be the best testimony to the country of the solidarity of construction interests in the new movement.

Full details of the plan are set forth in a comprehensive pamphlet, procurable from the temporary office, 1053 Munsey Building, Washington, D. C. The meeting will be held in the Washington Hotel. Mr. Hoover will preside.

TEMPORARY DIRECTING COMMITTEE, AMERICAN CONSTRUCTION COUNCIL,

R. C. Marshall, Jr.

Plans and Purposes of The American Construction Council

Broadly speaking, the purpose of the council will be to place the construction industry on a high plane of integrity and efficiency, and to correlate the efforts of existing organizations. Its purposes and plans somewhat more in detail are announced by Mr. Noble Foster Hoggson of New York, Director of the Associated General Contractors, as follows:

The first efforts of the council will be devoted to a solution of the more pressing of the many problems which await settlement. Among the most important of these are:

The formation of a code of ethics acceptable to the industry and to the public.

The gathering of adequate statistics so that the industry may operate intelligently. While there are partial statistics collected by many sources, they have not been brought together and interpreted in the light of all the facts.

A reduction of the national shortage of building mechanics and the establishment of the necessary apprenticeship system.

A national study of building codes and the working out of a program for carrying the recommendations into effect.

A revision of the existing freight rates on construction materials.

A stabilization of the construction industry to mitigate the evils of seasonal employment and the trade migration of labor.

City Plan Budget.—The City of St. Louis, Mo., has provided $20,596 for the use of its city plan commission during the year ending April 10, 1923. Of the total $19,036 is for salaries and wages.

Making the Most of the Construction Season

Statistics compiled by the Illinois Highway Commission reveal the fact that the average maximum number of days during which crews on highway work in Illinois were able to operate during the 1921 construction season was 120; during approximately two-thirds of the year the contractors' equipment was idle.

Even after contracts were awarded during the winter months and the spring breakup finds the contractor ready to go, the season during which the pavement may be built in the average American state is limited. When a paving contractor's equipment consisted of a small mixer, a few wagons, a dinkey, wheelbarrows and a supply of shovels, an idle day was not a great expense. Today, however, when road building equipment on a single job involves an investment of many thousands of dollars, the saving of a single operating day is of prime importance to the contractor.

The pavement manufacturer may profitably study the methods adopted by the factory manager when important orders must be filled in a limited time. One of the first expedients of the factory manager is the "night shift" which doubles the output without increasing the plant investment.

Because the season is short and the investment in paving plant is large, that part of the cost per square yard of pavement chargeable to equipment, rental and overhead has always been excessive. This cost may be materially reduced by doubling the yearly production with a two-shift crew. Many contractors have already availed themselves of this method of making the most of the construction season and the 1921 season presented many instances of the successful use of the double shift.

The results have been gratifying. In almost every case the night shift, working during the cooler hours, has consistently placed more pavement than the day crew. The quality of the pavement was as good as that placed during the day. This was accomplished with only a small additional equipment and two-mixer output was thus obtained with one-mixer investment.

During the summer months when the days are long, it is possible for the contractor to use two crews, each working eight hours without the need of artificial lighting. One crew, working from 4 a. m. till noon and the other from noon till 8 p. m. will under average summer conditions provide a 16-hour day during practically all of which there will be enough daylight for placing concrete.

The advantages of two-shift construction are not confined to the contractor. With such a plan, double the number of men are given employment and the road will be completed and opened to traffic in half the time. There will be a corresponding reduction in detour maintenance cost and in the expense and inconvenience traffic incurs when using the side roads.

Everything favors two-shift pavement construction. Only the custom of doing out-of-doors work by broad daylight has prevented its more general use. Labor is plentiful and the contractor must avail himself of every opportunity to make the most of his investment in plant.

There is another angle to this subject that must not be overlooked. A larger mileage of hard surfaced roads is imperatively needed. With a short construction season in which to provide these roads, the public has a right to demand that this season be utilized to the fullest possible extent—by two-shift or even three-shift organization—in order that the greatest possible mileage of highway may be completed each season and made available for the taxpayer's use.—Editorial in Concrete Highway Magazine.

Haulage of Concrete from Central Mixing Plants

Some time ago attention was drawn in an editorial column to the growing practice of mixing concrete for roadwork at central mixing plants and hauling it to the point of use by motor trucks. A notable instance of success by this method was in work done by the California State Highway Commission in the Imperial Valley, where haulage [illegible] of concrete [illegible].

[illegible] of this method [illegible] that the concrete has not lost strength appreciably through initial setting. Even though such has occurred to some extent, the mixture may be useful, as investigation has shown that concrete may be remixed with little or no loss of strength up to the third hour after the original mixing. Another source of possible trouble is in the segregation of the aggregate, which it has been found may be prevented, in some measure at least, by the use of hydrated lime.

Recent tests made by the U. S. Bureau of Public Roads indicate that a considerable time may safely be allowed to elapse between mixing and use without appreciable loss of strength. Gravel concrete of 1:1½:3 mix was hauled in trucks and the material tested at period of elapsed time varying from 15 minutes to 3 hours and 10 minutes. It was found that the average crushing strength of cylinders was very nearly the same for all specimens, but that the workability diminished markedly after the first hour. Apparently, the practicability of the method would depend upon workability rather than strength, as after 45 minutes the mixture was too dry for hand finishing, although it might have been used up to 2 hours of elapsed time with a pavement finishing machine. It thus appears that so long as concrete is workable after hauling, its strength would be sufficient, and that the most practicable way of utilizing concrete hauled from a central mixing plant is to employ a machine finisher. For road or street work where it is impracticable to mix concrete at the point of use this method has become very promising.—Editorial in The Canadian Engineer.

English Unemployment and the Importance of Highway Improvement

The necessity of providing work for the unemployed during the past two winters has considerably disorganized the normal program of outdoor work by local authorities, and much work which, under ordinary conditions, would not have been put in hand until the spring, has been proceeded with throughout the bad weather. Although this work has alleviated a great deal of distress, owing to the frequent stoppages due to inclement weather it cannot, of course, give as good a return for money spent as similar operations carried out during the spring and summer. Now the better weather is within measurable distance, however, local authorities will undoubtedly be considering still further activities in this direction. The largest item in the unemployment relief schemes (as in municipal work in more normal times) is road construction and reconstruction, and rightly so; for the increasing use of motor transport is emphasizing more every day the important position the roads will take in the trade and commerce of the country in the future. Motor manufacturers are using every endeavor to regain for the roads the popularity they once enjoyed, and the penetration of heavy char-à-bancs and lorries to rural districts has presented to local authorities a problem which will have to be solved. The advent of the motor omnibus led to the reconstruction on more solid lines of the roads which they used, and it is obvious that those responsible for the maintenance of second- and third-class roads in rural areas will have to follow in the same direction. Motor transport has come to stay, and it is essential for the well-being of the country that a network of roads should be formed to accommodate this class of traffic. Many of the existing roads are entirely unsuited for heavy or fast traffic, and their widening and reconstruction will involve immense expense. But it is a position which has to be faced, and we are convinced that it would be false economy to rebuild these roads on any but the best system known to modern science. In such matters the initial outlay is not the chief consideration and, although it might be more costly in the first place, the concrete road, by reason of the length of its life and low upkeep costs, is worthy of very serious consideration.—Concrete and Constructional Engineering, London.

Highway Planning in Maryland.—For the formulation of a general plan of highways lying within three miles of the city line, a street planning commission was appointed early in May by the County Commissioners of Baltimore County. The commission is authorized by the Legislature of 1920.

The duties of the commission are to make a topographical survey of that part of the county adjacent to the city and prepare a map showing the location of the highways and other data.

Construction Methods on Southern Indiana Road Job

By J. D. STEMM,

Project Engineer, Indiana State Highway Commission,
Boonville, Ind.

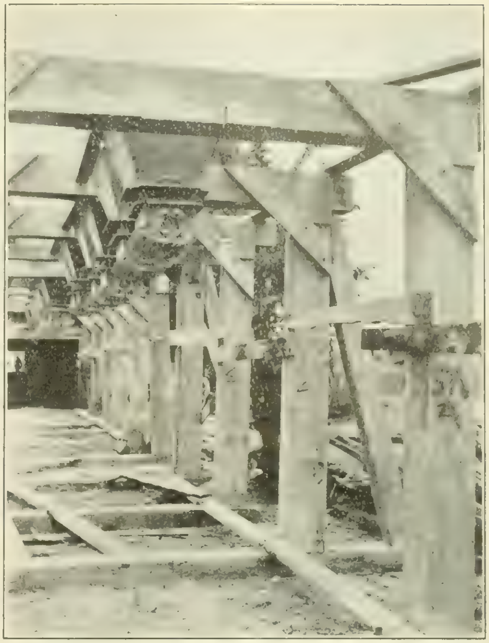
Well co-ordinated unloading, hauling and mixing equipment featured the 10¾-mile concrete road job of the S. R. Adams Construction Co. in Warrick County, Indiana. This section is known as Federal Aid Project No. 168, and extends to Boonville from the west county line; it is on the Evansville-French Lick Highway. A complete industrial railway outfit was used in building the pavement.

Two setups of the central proportioning plant were made: the first at Chandler and the second at Possum Ridge, three miles from Boonville. Five and a half miles of pavement were placed from the first setup, with a maximum haul of three miles, and the remainder from the second setup, with a maximum haul of 2½ miles. Aggregates were handled from cars to the tunnels by an Austin gasoline convertible crane and clamshell bucket. This crane earlier had done excellent work as a dragline during the grading operations. With it, over 12,000 cu. yd. of earth borrow were handled, and a large share of the ditches were cut. The clamshell proved valuable in excavating for abutments at the bridge sites. The boom is 35 ft. long and the bucket is of ¾ cu. yd. capacity. In 10 hours with this outfit two men, an operator and a man in the car, could unload about six cars of crushed stone or eight to ten cars of sand, each car holding approximately 33 cu. yd. of material.

Between the 125-ft. sand tunnel and the 250-ft. stone tunnel was located the cement house. This was 98 ft. long by 12 ft. wide, and was built with a roof made up of 8 by 12 ft. removable sections, designed to permit the use of bulk cement handled by the clamshell. Over the center of the industrial track, steel hoppers were bolted to wooden supports below the floor and radial gates were fastened to these hoppers. The floor of the cement house was made high enough so that the radial gates were at the same distance above the track as those in the aggregate tunnels. Although the cement house was designed to allow the use of bulk cement, sack cement was used throughout the job.

In moving cement from the car to storage a flat car running on a narrow gauge track was found efficient. Loaded with 50 sacks, the car was pulled by a small hoist up an incline leading from the railroad siding to a door at the center of the cement house. Here it was run upon a turntable, and then pushed as far as desired along a track that extended for the entire length of the cement shed. Space was left around the hoppers so that men could empty six sacks into each in preparation for loading the batch boxes. With this method, a train could be loaded very quickly.

When cement was being received at about the same rate as used, the cement house was saved for storage space and a different plan followed. A platform about 20 ft. long was erected near the cement house. On this, 200 to 300 sacks were set up at a time. Then the train of batch boxes was brought alongside on a siding, and six sacks of cement emptied into each box. While this plan required a somewhat longer time for loading, it was not so objectionable from the standpoint of dust.



Measuring Hoppers for Cement.

Trains were made up of from 8 to 14 cars, depending upon the grades encountered. The 7-ton Austin gasoline engines successfully handled 8-car trains over a 5 per cent grade. Cars, batch-boxes and track were also of Austin make. Each car carried two batch-boxes. Sufficient radial gates were placed in the aggregate tunnels so that there was one pair over each box when the train was once spotted.

With the 21E Austin cube mixer, a maximum of 1,200 sq. yd. of 1:2:3 concrete, 6-8-6 in. thick was placed in ten hours. One thousand square yards was considered a good day's work. No expansion joints were used, and dowels were placed across all construction joints. Five ¾-in. rods, 4 ft. long and wrapped in tar paper, were used at each joint, with the rods extending equally into the two slabs. Finishing was done by a Lakewood machine running on Heltzel side-forms. A Lakewood subgrader and Huber 10-ton roller were employed in preparing the subgrade.

The following statement gives in detail the usual organiza-

Unloading Plant on Southern R. R., for First Set Up.

Section of Evansville-French Lick Highway, Looking East Toward Boonville.

tion of the contractor's crew on this job exclusive of rough grading and culvert work:

MATERIALS PLANT	
Crane—	
Operator and man in car	2
Handling cement—	
Opening and emptying sacks unloaded from car	3 or 4
Cleaning and baling sacks	1
Loading sand and stone	1
HAULING	
Track crew	2
Train men (3 crews of 2 each)	6
FINE GRADING	
Roller operator	1
Laborers, with subgrader	4
MIXING AND PLACING CONCRETE	
Form setters (also remove forms)	4
Dumping batches	2
Mixer engineer, fireman and helper	3
Spreading concrete	2
Finishing machine operator and hand finisher	2
Sprinkling concrete	1 or 2
Covering pavement	2
Pump operator	1
SUPERVISION AND MISCELLANEOUS.	
Superintendent	1
Foremen	2
Night watchman	1
Waterboys	2
Timekeeper	1

F. A. Gageby was in charge of the work for the contractor and the writer served as project engineer for the Indiana Highway Commission.

Junior Civil Engineer and Junior Highway Bridge Engineer Examinations

The United States Civil Service Commission announces examinations for the above positions to be held June 21 at various places in every state. The salaries offered are $1,200 per year for junior civil engineer and $1,200 to $1,600 per year for junior highway bridge engineer, with a possibility of bonuses up to $20 per month for satisfactory service. Examination subjects and weights are:

1. Mathematics	20
2. Strength of materials and applied mechanics	25
3. (a) Civil engineering (including surveying) or (b) highway bridge engineering	30
4. Education, training and experience	25
Total	100

Subject No. 4 requires graduation in civil engineering from a college or university of recognized standing not later than 1922. Full information on these positions and examinations will be furnished upon request by the Civil Service Commission.

Highway Bridge Engineer Examination

The United States Civil Service Commission will receive applications until June 27 for the position of highway bridge engineer at a salary of $1,800 to $2,100 per year, with possibility of a bonus up to $20 per month for satisfactory service.

Competitors will not be required to report for examination at any place, but will be rated on the following subjects, which will have the relative weights indicated:

1. Education and preliminary and general experience	45
2. Special experience and fitness	55
Total	100

The ratings will be based upon competitors' sworn statements in their applications and upon corroborative evidence.

Applicants will be given full information upon request to the Civil Service Commission.

Earth Road Maintenance in Massachusetts

Some interesting points on the maintenance of country roads in Massachusetts was given by R. L. Phillips, Division engineer of the State Highway Department in a discussion at the last annual convention of the American Road Builders' Association. We quote as follows from the recently issued proceedings of the convention.

In 1918 Massachusetts passed an act in reference to small towns having a valuation of less than $3,000,000. The state assisted the town by giving it up to $50 a mile. That is, it takes the valuation of a town and divides up the number of miles of road in the town and that gives a certain valuation per mile. This act was passed in 1918. I have charge of two counties in Western Massachusetts. Last year under this act we had about 1650 miles of road to maintain. The average amount of money we have in all the towns is $88 a mile. Well, that sounds like a pretty small sum of money; so it is a problem we have to face in towns with very steep hills, and these towns have a very small population—some of them not over 100 inhabitants; in fact, during the last ten years, these towns have gone back so far that they have not touched their roads. We cannot talk about sand clay or gravel or anything else to make the road passable. The way we have gone at it is this: we believe in a very small maintenance crew; because rather than work twice a year we try to work continuously in small gangs. About the first thing we had to do was to cut the brush back—it was so close you could not turn out. Not only did that give a wider road, but it dried the road up. The next thing, we found we had to supply sufficient drainage.

In Western Massachusetts they still cut considerable lumber, and we were confronted with a truck which weighed 5 tons. A load of lumber with a trailer weighing, combined, 24 tons, was hauled into Springfield. Take that sort of a road with a 24-ton truck and trailer, and you have some proposition. We also found that the culverts were made of plank or stone laid up closely. A heavy truck tilts the top stone and the weight of the truck breaks these culverts. It is absolutely useless to try to put gravel, stone or anything else on until you have properly drained that road. We tackled the problem of drainage. We use on account of transportation and ease of laying, the corrugated iron pipe.

Ten or fifteen years ago, when I knew more about it than I do now, I used to advocate the road drag in small towns. I am getting all over it now. I found the road drag might be a good instrument, but it is 99 per cent brains and 1 per cent road drag, and they only used the road drag, so we got flat roads. The line of least resistance is always the easiest way. We sent out an intelligent man, as we supposed, and he pulled the drag up the middle of the road and back and the first thing we knew we had a miniature canal. The thing to do was to open up the culverts and ditches. We endeavored, with the best materials we had, to get suitable ditches and suitable drains, and where there were mudholes, we tried to put in stone drains.

We are gradually getting the best of those roads. Understand, this is a small amount of money we are working with. We have trained men, not necessarily engineers, but practical men whom I have to supervise, in—say fourteen towns. The average of these spends all his time chasing around. Don't think that because we give these towns this money, the men run out and go to work unless we prod them every now and then. Prodding is a part of the work. I build roads from the highest type down, but I think this earth road problem is the biggest we have to face. The State of Massachusetts has a mileage of perhaps 24,000 miles, and I think, without any exaggeration, over 15,000 miles of road in Massachusetts today are of this type. We do not expect that you are going to go down there and see some beautiful smooth boulevards, but we claim that in three years we have made enough improvements in our country roads so that it is getting noticeable, and if we can keep on with this system, in ten years there will be a very noticeable improvement in all the towns in Massachusetts with a valuation of less than $3,000,000. It is a very interesting problem. Three years ago when this act was passed I had charge of five counties and I handled 72 towns. That means two hundred and sixteen individual selectmen to please and the population to please. It was some job.

The Financing of Public Highways

Historical Outline of Highway Development—Laws, Problems and Accomplishments of Highway Finance in Louisiana—Conditions of 1922 and Suggestions for Increased Financing

By H. H. TRUXILLO.
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Probably the first road of historical importance was the Appian Way. This road was begun by Appius Claudius in 312 B. C., and was completed by Julius Caeser at a later date. There is also record of a road built by Cheops to transport material for the great pyramids at Ghizeh in Egypt. However, the Roman road was the first of which we have any definite knowledge, and it was the forerunner of the great system of Roman highways that connected all the parts of the Roman Empire. The route of this road was from Rome to Brindisi, a distance of approximately 361 miles. It was laid in four successive courses on a prepared foundation, the average overall depth being about $4\frac{3}{4}$ ft. Such a road could safely carry the heaviest concentrations of great obelisks, columns, etc., then used by the Romans. All of the Roman roads were constructed mainly for military purposes. They were built by slave labor and the materials used in their construction were paid for out of the royal funds. It has been estimated that to build such a road today would cost $245,000 per mile.

Previous to the time of the Romans, men had little need for roads. Inland trade was small, the great marts of commerce were the sea ports, and as a consequence road building was practically unknown and not needed. From the decline of Rome until the beginning of the eighteenth century road building was a lost art. The condition of the roads in continental Europe and the British Isles was very bad. Great pits, morasses and bogs were to be found in every highway. Robbery flourished. If a party started out on an overland voyage and was not accompanied by a bodyguard and a crew of men to pry him out of the mud holes he stood in great danger of losing his possessions and sometimes his life.

The birth of Telford and Macadam in Britain and Tresaguet in France marked the beginning of modern roads. These men saw that roads were vitally necessary to a nation's prosperity.

Good Road Beginnings in America.—In America the State (or rather the colony) of Virginia was the first to enact good roads legislation. This first highway law provided that each man should render a given number of days at labor on the public roads. The other colonies had similar legislation. With the adoption of the United States Constitution it was provided that roads should be built by the Government to connect the various parts of the thirteen States. However, nothing was done in this respect until 1792. In that year the first toll road in the United States was built, connecting Philadelphia and Lancaster, Pa. Many thousands of miles of toll roads were constructed in the period from 1792 to 1830.

In 1806 the Cumberland road was authorized by act of Congress. This road began at Cumberland, Md., on the Potomac River and extended to Steubenville, a small town on the Ohio River. It was later extended to St. Louis, Mo. From 1806 to 1835 when the last direct appropriation for the Old National Road, as it was called, was made the total appropriations for construction amounted to $6,824,919. This money was largely taken from the sale of public lands.

Between the years 1821 and 1837 the State of Kentucky completed 343 miles of state roads. This was the first state road building policy in America. All work was stopped by the financial panic of 1837.

By the year 1850 local turnpike companies had taken over practically all of the Cumberland Road. However, the introduction of the steam railway in 1830 and its gradual development soon put an end to the toll road system. The cost of collections and the inconveniences placed upon travelers by the toll system also contributed in a large measure to its failure. The toll roads were of great benefit to commerce and agriculture; and under the conditions of the period they were probably the best that could be had. The capital to pay for these roads was derived from the subscriptions of states, counties and individuals.

From the close of the Civil War until 1891 practically nothing was done towards road building in this country. The National Government had discontinued all appropriations for National roads; the turnpike companies had virtually passed out of existence; and nothing was done within the states save the local road work of the towns and counties. Road funds were hard to get, and as a result the most that the various local units accomplished was a slipshod maintenance of existing roads.

State and Federal Aid Acts. In 1891 New Jersey passed the first state aid law. This law provided that roads should be built and paid for as follows: the state to pay $33\frac{1}{3}$ per cent, the county to pay $56\frac{2}{3}$ per cent and the immediate property owner to pay 10 per cent. This system proved so successful that by 1917 it had been adopted by practically all of the states.

In 1916 Congress passed the Federal Aid Road Act. This act provides that the federal government shall pay half the cost of constructing roads in a state under the following conditions:

(1) The state must have a highway department.
(2) The road must be of a substantial character.
(3) The cost per mile must not exceed $40,000 exclusive of bridges of more than 20-ft. span.
(4) The roads so constructed must be properly maintained at the peril of discontinuing all appropriations should the state fail in this respect.

The Federal Aid appropriations for each year since the creation of the act have been as follows:

1917	$ 5,000,000
1918	10,000,000
1919	65,000,000
1920	95,000,000
1921	100,000,000
Total	$275,000,000

A bill providing for further Federal Aid appropriations of $50,000,000, $65,000,000 and $75,000,000 respectively for the fiscal years 1923, 1924 and 1925, has passed the Senate and similar legislation is being considered by the House.

Louisiana's Highway Problem and the Manner in Which It Was Met. -Previous to 1910 the state of Louisiana had no highway department. All highways were constructed through local funds, and without state aid. In 1910 a Highway Department was created, this department being under the jurisdiction of the Board of State Engineers. The head of the department was the Chief State Highway Engineer. Under the then existing law there were four methods by which state aid could be extended the various parishes*, namely:

(1) Monetary State Aid by Contract.
(2) Convict Labor State Aid.
(3) Road Outfit State Aid.
(4) Force Account State Aid.

The revenues to make state aid possible were obtained through the levy and collection of a general tax of ¼ mill on the dollar of assessed valuation. The money available from this source amounted to about $150,000 per year which was far inadequate. The revenues from auto licenses did not go into the state highway funds, but were remitted to the parishes. The parishes met their quota of the cost of state aid roads with the auto license fees and a general property tax, or by bond issues payable with special taxes or a general tax.

From the years 1917 to 1920 Federal Aid funds matched with parish funds, largely, enabled the Highway Department to enter upon an extensive road building program. This program was the construction of a system of "Main Line" or "Market Highways" connecting the various parish seats and trade centers and the principal roads from adjoining states, amounting in all to about 5,000 miles of improved highways when completed. As there are about 24,000 miles of highways that are not included in the highway system,

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*The parish in Louisiana corresponds to the county in most other states.

[illegible] roads.

[illegible] and the [illegible]

Louisiana Highway Commission. [illegible]

Therefore, when the new constitution was drafted in 1921 important changes were made in the highway department. By Act No. [illegible] of the Legislature of [illegible] the [illegible] of the state were placed under the Louisiana Highway Commission, the members of which are appointed by the governor. The Commission is not subject to the Board of State Engineers, but is responsible only to the governor. It is the duty of the commission to [illegible] and determine all questions relating to the general policy and conduct of highway work in the state, to receive the report of the State Highway Engineer, and to act upon all questions relating to recommendations, reports and such other matters as it may deem advisable to submit to the Governor or to the Legislature.

The powers and duties of the State Highway Engineer are confined to matters dealing with the actual construction and maintenance of roads. Subject to the approval of the Commission he shall have supervision of the construction, repair and maintenance of all roads and bridges included in the State Highway System.

In the parishes the police jury has jurisdiction of all road and bridge work and may levy taxes and issue bonds to supply the necessary funds. The parish surveyor appointed by the governor may, on order of the police jury, be employed on local roadwork.

Convict labor may be employed in the construction and maintenance of public highways. The terms and conditions under which convicts shall be worked upon said highways shall be agreed upon between the Commission and the General Manager of the State Penitentiary.

The work before the Highway Commission at present is the completion of the Main Line or Market Highways which form the Highway System.

It must be understood that the Highway Commission is not concerned with the roads within a parish which do not form a part of the Highway System. Until these roads become a part of the Highway System no state or federal funds can be spent upon them.

Procedure in Financing a Road Which Is Included in the Highway System. (1) The police jury or road district officials make a written application to the State Highway Engineer for the construction or improvement of the road in question.

(2) Upon receipt of this application the State Highway Engineer makes the proper investigations to determine whether the parish or road district will be able to pay its share of the cost which shall not exceed 25 per cent.

(3) If the Highway Engineer is satisfied that the parish will be able to pay its part of the cost of the proposed improvement he then lays the matter before the Highway Commission. The Highway Commission may approve the project and authorize the expenditure of the 75 per cent of the cost of the road to be paid by the state, or it may approve the project and submit it to the Federal Aid District Engineer as the first step in securing federal funds.

(4) The District Engineer then forwards the project statement with all estimates, etc., to the [illegible] and Secretary of Agriculture at Washington. If the [illegible] the District Engineer and the state officials are so notified and the District Engineer then inspects the proposed highway. With the approval of the District Engineer the state [illegible]

When federal funds are available the federal government pays 50 per cent of the cost of the road, the state pays 25 per cent and the parish pays 25 per cent. [illegible] credit of the General Highway Fund.

The cost of maintaining a road so constructed is divided equally between the parish or road district and the state at present, because of the inability of the state to pay all maintenance costs as prescribed by law.

The Highway Commission may construct a road in a parish or road district without the approval of the police jury or governing body and pay for this road with state or federal funds, but the Highway Commission will not interest itself in further road expenditures in this parish until it has paid its 25 per cent of the cost of the initial road.

Whenever a state highway goes through a town or city, and it is desired to increase the width of the highway within the city limits, the additional cost of widening the highway must be paid by the city or town.

Whenever a city or parish or road district has constructed a road which forms a part of the highway system previous to the creation of the highway system this city, parish or road district is reimbursed for such improvement, and the cost of maintenance of this improvement is equally borne by the state, and road district, town or parish.

Sources of the General Highway Fund.—Auto Licenses and Fees. In order to provide funds for carrying out the provisions of Act No. 91, the Legislature in 1921 appropriated the sum of $2,500,000 for highway work for the fiscal year ending June 30, 1922, and $[illegible] for the fiscal year ending June 30, 1923. This money is available for highway work provided there are sufficient funds in the General Highway Fund to supply it, and provided further that the money is actually necessary. The General Highway Fund is derived from:

(1) Motor vehicle manufacturers' and dealers' licenses; a regular license fee of $10 for plates, and an additional tax for each type of vehicle manufactured.

(2) Motor vehicle chauffeur's license of $5.00.

(3) Motor vehicle licenses.

  a. Private or personal automobiles constitute the First Class; the annual license tax is $0.68 per h. p. with a minimum of $15.

  b. Second Class vehicles are those used for carrying freight or merchandise and which have a carrying capacity in excess of 750 lb. The license fees range from $10 to $25 per thousand lb. carrying capacity, plus $0.68 per h. p.

  c. Third Class. Vehicles used regularly in carrying passengers for hire upon the streets or highways. The rates are $2 to $5 per passenger plus $0.68 per h. p. For motor vehicles with a carrying capacity of 10,000 lb. the license shall be the fee for the 10,000 lb. vehicle plus $0.68 per h. p. plus $1.50 for each 1000 lb. above 10,000.

  d. Motorcycles $5.00.

  e. Log wagons $10 for each month of service on the highways.

  f. Horse drawn vehicles in commercial use, $0.25 per 100 lb. rated carrying capacity.

(4) A license tax of $0.01 per gallon on gasoline and all motor fuels sold within the state.

The legislature has the authority to pass to the General Highway Fund any moneys derived from any other source.

Highway Bonds. Highway bonds are used only when the income derived from annual road taxes is too small properly to undertake work of an extensive nature. When such is the case the parish or other political unit issues bonds so that the money may be available immediately, and then uses the yearly taxes to pay principal and interest when they become due. The principle types of bonds used are Serial, Sinking Fund, and Annuity bonds.

The serial method retires a fixed amount of the principal annually. Besides paying interest on the bonds each year a certain definite part of the total indebtedness is paid also so that year by year the total principal on which to pay interest is gradually decreased.

Sinking Fund bonds are straight term bonds. The interest is paid each year but no part of the principal is paid until the date of maturity of all of the bonds. In order to pay for the bonds when they become due the road taxes are deposited at interest. This interest is usually lower than the bond interest. The amount placed in the sinking fund is such that at the date of maturity of the bonds the principal and interest on the sinking fund will be large enough to pay the face value of the bonds.

The principle objection to sinking fund bonds is that dishonest officials may draw upon the sinking fund for other than highway purposes so that when the time comes to pay the bonds the fund on deposit may not be adequate to do so; then there is always time lost between the collection of the tax and the proper investment of the sinking fund

Annuity bonds are arranged so that a uniform periodic payment will discharge the debt within a given time. The annuity bond serves the same purpose as the serial bond but costs slightly more.

The principle advantages to be derived from serial bonds are:

(1) Serial bonds minimize the dangers involved in a bonded debt. If the political subdivision issuing the bonds is unable to meet principal and interest each year there is a public default and community credit is seriously injured. Thus the serial bond makes absolutely certain the gradual retirement of the public debt.

(2) Serial bonds are the cheapest. The total cost of a $100,000 sinking fund bond issue at 5 per cent maturing in 20 years is $172,722—$100,000 principal, $72,722 interest. The cost of a serial bond issue for the same term and at the same rate of interest is $152,500.

(3) Serial bonds maturing in from one to twenty years make an investment in bonds attractive to all classes of people and thereby facilitate their early disposal

There has been much discussion as to the term of highway bonds. That is, as to whether the bonds should mature in 10, 20, 40 or more years. The consensus of current opinion is that highway bonds should mature within the life of the improvement for which they were created

In the state of Louisiana the parishes may bond up to 10 per cent of their assessed valuation. This 10 per cent includes the existing bonded indebtedness. No parish bonds "shall run for more than 40 years, nor shall the rate of interest be greater than 6 per cent, or the bonds be sold for less than par." All such bonds become due and must be paid in annual installments beginning not more than three years after the date of issuance.

In regard to state bonds for highway purposes Article 6, Section 22 of the Constitution reads as follows: "No debt shall be created or certificates of indebtedness or bonds issued, to be paid in the future out of the proceeds realized from any state tax or license........but the said licenses and taxes shall be collected from year to year and expended for the purpose of the construction and maintenance of the system of State highways and bridges." This clause was placed in the Constitution through a desire on the part of the men who wrote it to abolish the high cost of bond interests, and to run the State Highway Department upon a cash basis.

Louisiana Highway Finances for 1922.—The Highway Commission proposes to spend $2,500,000 this year, and $5,000,000 in 1923 if the funds are available. Up to date there is available from the auto license tax $1,469,000. The gasoline tax which was expected to yield $750,000 has so far furnished $140,000 in four months, or at the rate of about $450,000 for the entire year. There is no general property tax available for highway purposes. Federal funds amount to $996,000. The total funds are distributed as follows:

	Federal aid.	State funds.	Parish funds.	Total.
	$996,000	$ 498,000	$ 498,000	$1,992,000
		*500,000[1]	500,000[1]	1,000,000
		†921,000[2]	308,000[3]	1,229,000
Total	$996,000	$1,919,000	$1,306,000	$4,221,000

*Maintenance. †Construction. [1]50 per cent. [2]75 per cent. [3]25 per cent.

This is the contemplated distribution of highway funds. It is based on the assumption that 25 per cent of the Commission funds will be expended for maintenance and the remainder for construction purposes; also that the parishes will contribute 50 per cent of the maintenance costs and 25 per cent of the construction costs. As a matter of fact, the Louisiana Highway Laws have been changed so often that the parishes have in many instances ceased to meet the Constitutional requirements. In some parishes the state and parish share maintenance costs on a fifty-fifty basis, in others they do not. Many of the parishes are not waiting for state aid, but are constructing roads entirely at their own expense. On the basis of such unsettled conditions highway officials estimate that total road expenditures for the year will approximate $8,000,000. This money will provide for the construction of from 600 to 800 miles of highways, which is economically too slow progress in providing an efficient system of state highways.

Attention is called to the fact that the Highway Commission funds as estimated above are about $581,000 short of the authorized $2,500,000. This delinquency, together with the statewide demand for faster progress in highway construction, calls for an additional source of revenue for road purposes.

While there is much pressure being brought to bear upon the present session of the Legislature for tax reductions, still highway conditions demand the imposition of new taxes. There should be a general tax on all taxable property, the proceeds from this tax to go into the General Highway Fund. Strictly speaking road taxes are not taxes but are an investment. Good roads above all things will make rural life more attractive, will help to keep our boys and girls on the farms by making for better farming conditions, and will repopulate our much depleted rural districts.

The funds that go for highway work should be increased. Three possible methods of doing this would be to:

(1) Increase the bonding capacity of the parishes

(2) Permit the state to issue bonds.

(3) Increase the General Highway Fund by levying an ad valorem tax of 2 mills on each dollar of assessed valuation.

To increase the bonding capacity of the parishes at the present time would be inadvisable as the parishes are already heavily bonded. To permit the state to issue bonds for highway purposes would give instant relief and would allow for the construction of many hundreds of miles of much needed roads. The chief difficulty in this method is that no legislature wants to shoulder the responsibility of placing a large public debt upon the state. Therefore, the last method is the only one which at present seems feasible. In 1921 there were 26 states which levied a general tax for highway purposes. The average rate of tax for these 26 states was 1.6 mills. For the state of Louisiana, with a property valuation of approximately $1,700,000,000, the imposition of this 2 mill tax would add about $3,400,000 yearly to the Highway Fund. A 2 mill tax is not unduly high. The state of Maryland has a 3½ mill tax for highway purposes. Nebraska has a 3⅕ mill tax, and New Mexico levies a 4½ mill tax. The revenues from such a tax plus the money from other sources would enable the Highway Commission to spend approximately $6,500,000 yearly for highway purposes.

The immediate need of the state is good roads. A well built system of highways by reducing transportation costs benefits both producer and consumer. Whether one lives in the city or in the country he is benefited by the improvement of such roads either directly or indirectly. Therefore the best and most equitable form of taxation would appear to be an ad valorem tax on all taxable property.

Proposed Extension of Univerity Engineering Courses

Late in May the deans of 17 midwestern engineering colleges met in Chicago to discuss improvements in their courses, and in particular the increasing of the engineering course from 4 to 5 years.

The conference was called by Dean Raymond, University of Iowa; Dean Ferguson, University of Nebraska, and Dean Marsden of Iowa State College, to discuss a larger curriculum for the engineering colleges.

A resolution was adopted advocating that the first two years of the engineering course should be uniform for all without regard to what branch of engineering was to be specialized in. Bachelor A, of science, an engineering degree would be conferred at the end of the fourth year, and at the end of the fifth year, a master of science in engineering degree would be conferred. As much of the technical teaching as possible should be pushed into the last year, which would be a year of specialization and its place in the curriculum be given to real arts, the resolution having in mind to broaden the education of the engineer.

The conferees will present to their respective governing bodies the proposition of engaging the curriculum, and a second conference has been set for June 18, at Urbana, Ill., when the annual session of the society for the promotion of engineering education meets there.

The Modern Granite Block Pavement

Recent Developments Outlined in Paper Presented at Philadelphia City Paving Conference

By CLARENCE D. POLLOCK
Consulting Engineer, New York City

The modern granite block pavement as laid at present is placed on a cement concrete foundation, usually 6 in. in thickness, with a cushion of 1 in. of sand or a mixture of cement and sand in the proportion of 1 part of cement to 4 parts of sand by volume. The standard block 8 to 12 in. in length, 3½ to 4½ in. in width and 4¾ to 5¼ in. in depth is generally used. Where traffic conditions are such that the street cannot be blocked off for a sufficient time to permit the grout to set properly an asphalt mastic filler is quite generally used. This asphalt mastic filler is of rather recent origin but has been very satisfactory when properly mixed and placed. In place of the asphalt a coal tar pitch is sometimes used and also a mixture of coal tar pitch and asphalt. The coal tar pitch and sand mastic has not given very good results, but a mixture of 3 parts of coal tar pitch with 1 part of asphalt has given much better results as it is less susceptible to temperature changes than the coal tar pitch alone.

The Bituminous Filler.—The usual specification for the bituminous filler calls for a mixture of the paving cement and hot dry sand in the proportion not to exceed 1 part of sand to 1 part of the paving cement by volume, or as much sand up to this proportion as the paving cement will carry. The sand is usually specified as all to pass the 10 mesh sieve or all to pass the 10 mesh and 80 per cent the 20 mesh sieve.

The common method of mixing this bituminous mastic is to draw the hot asphalt or pitch from the heating kettle into a steel push cart or a wheelbarrow and then shovel in hot sand, counting the shovel fulls and then stir with a perforated hoe or rake. In some places a small gasoline mixer is used. These methods are crude and it requires great care in order to secure good results. If the sand is coarse, or damp or if too much is added, the mixture will not run into the joints and completely fill them. Coarse sand will settle out and lodge in the closer joints and damp up the mastic. Too much sand will make the mixture so stiff that it will not flow into the joints. The usual practice is to dump the hot mixture from the push cart or wheelbarrow upon the surface of the pavement and push it into the joints with a hoe or a squeegee. This operation should be carried on rapidly and care used not to push the mastic out too thin as it will chill before it can penetrate the joints fully.

The asphalt should be homogeneous, its melting point between 115° and 135° F., not less than 98½% soluble in carbon tetrachloride, its penetration at 77° F. not less than 60 nor more than 100, and at 100° F. its penetration should not be more than 3½ times that at 77°. Its ductility at 77° F. should not be less than 40 centimeters at the penetration called for. It should not lose more than 3% by volatilization when maintained at a temperature of 325° F. for five hours, and the penetration of the residue after such heating should not be less than one-half of the original penetration.

After the hot paving cement and sand mixture has been flushed into the joints thoroughly a small amount of clean sand should be spread over the surface.

The Sand for the Mastic.—The sand used in the mastic should be a uniform fine grained sand as this will remain in suspension better and will not clog and dam up the closer joints and thus prevent the flowing of the filler. As was mentioned above, the present mixing methods are crude. The gasoline mixer is an improvement on the hand mixing, but there is a good opportunity to devise more accurate methods of measuring the materials in order that the amount of sand used shall be uniform. It is also desirable that tests be made to determine more accurately the proper amount of sand to use. This should be as much as possible and still permit the mixture to flow readily into the joints. From observation this would seem to be in the neighborhood of about 40%, but we hope to see some test sections tried, varying the amount of sand from say 30% to 50%, using a good fine sand such as an asphalt sand.

This filler in its crude state has proved so satisfactory that it seems well worth while trying to eliminate as much of the guesswork as possible and make it more "fool proof."

The Cement Grout Filler.—In connection with the cement grout filler, the greatest improvement has been the more general use of a machine mixer such as a small batch concrete mixer with a spout or trough which delivers the grout directly onto the pavement. This gives much more uniform results than the old hand method of mixing the grout. Here also it is important to use a uniform fine grained sand in order that it may be held in suspension until delivered in the joints of the pavement.

To obtain good results with a cement grout filler even greater care and attention to details is required than with the bituminous mastic. Any carelessness such as permitting sand to get part way up in some of the joints so that the grout does not penetrate to the bottom will cause bad defects in the pavement, as the thrust from expansion will have to be carried by the upper part of the joint and this will crush the heads of the blocks.

Since the general use of the shallow cushion between the blocks and the foundation, there has been a tendency to slight the ramming. This is wrong. It is just as important as ever to ram the blocks thoroughly and then back-ram them after raising any low blocks. If this is not done the traffic will later pound down the shallower and poorer bedded blocks and a poor surface will be the result.

The Dry Cement Mortar Cushion.—With a cement grout filler and heavy traffic an improvement has been the use of a dry cement mortar cushion of 1 part of cement to 4 parts of sand. This gives a very solid and firm pavement as the mortar cushion has an opportunity to set while the grout is getting its set. This cushion has been used in some places with a bituminous filler, but here the traffic is permitted to pass over the pavement before the cushion can obtain much of a set and it would seem to be a waste of money to use the cement in the cushion. It will set in places where traffic does not pass over it and the set will be broken where it is subject to traffic.

The present standard block specification with proper inspection produces about as good a block as can be made without making the cost prohibitive. With good inspection these can be paved with close joints and with thorough ramming a good surface can be obtained and maintained, but as has been suggested previously, while there has been considerable improvement in the joint filler, there is still opportunity for much improvement.

It is urged that the engineers of municipalities having charge of granite paving work try out various mixtures of sand and asphalt and thus find out in actual service what is the best mixture within reasonable working limits. In such tests care should be taken to use uniform fine grained sand which is thoroughly dry and hot. This mastic should be agitated by mechanical means until it is flushed into the joints and the crude method of heating the sand by placing it over iron pipes containing wood fires, as is still frequently done, should be avoided. Fine hot asphalt sand, when it can be obtained, gives the best results. A practical method of measuring the sand and asphalt should be provided as the method that is now quite general of using a shovel to measure the sand is crude and does not give uniform results. Proper attention to these details should produce a filler that will make the modern granite block pavement about as near an ideal pavement for heavy traffic that it is possible to produce at a reasonable cost.

Activities of the Asphalt Association

Among other resolutions adopted at the recent Annual Convention of the Asphalt Association, in New York City, was one urging open competition between all types of paving construction, and another for increases in compensation for highway engineers. The association also went on record as in favor of wider roadways and the elimination of grade crossings, the widening of curves and a more stringent regulation of traffic.

The secretary's report showed that about 40 new members had been added to the association during the preceding year, and that several new branch offices had been opened. In the future, the association is to hold meetings at the same time and place as the annual good roads congress and show. Joseph R. Draney was elected president, and J. E. Pennybacker was elected secretary.

Other officers and directors were also elected.

Method of Figuring Street Intersection Grades

Street intersection grades often keep the municipal engineer burning the midnight oil. No fixed rule for figuring grades will apply everywhere. A method that has been successfully used at Everett, Wash., where steep slopes are frequent, was described as follows in Concrete Highway Magazine by Maj. A. B. Cutter, City Engineer.

1. Draw a sketch of the intersection to any convenient scale. For ordinary street widths 1 in. = 10 ft. will give a drawing which will fit a double page in the field notebook, with space for the lettering.

2. Connect the curb radius points G (see Fig. 1) by straight lines. Then the elevation of the pavement at A, C or E is the mean of the corresponding gutter grades at D plus the total crown of the pavement. The elevation at B should be one or two in. above a straight grade between A and E or C and C.

3. Locate points on the respective center lines either by quartering the curb arc, as on ABC, or by measuring given distances on the center line, as on CBE. The latter method is more easily reproduced in the field before the curb returns have been set.

4. Connect these points on the center line with the curb radius points G by a straight line and measure the unknown distances.

5. Figure straight grades on the center lines AB, BC and BE, and on the gutter lines around the arc of the curb DD.

6. Elevations between the points on the gutter line and those on the center line are figured by the parabolic curve equation

$$\left(\frac{a}{b^2}\right) e^2 = y$$

when

a = difference in elevation } Between points on the center line and corresponding points at the gutter.
b = distance
e = distance between the point on center line and the point whose elevation is desired.
y = fall from point on center line to point in question.

Results obtained by this method may need to be adjusted to fit special conditions.

When the slope across the intersection is rather steep, one gutter line may be above corresponding points on the center line. If a combination curb and gutter is used, with an apron sloping toward the curb, the pavement and apron will meet in a ridge which will not look or wear well. This may be avoided by figuring elevations on an arc, as FF, near the apron line, at about the elevation of the apron edge, so that no ridge will be formed. Then conneet points on this arc with corresponding points on the center line by a straight grade.

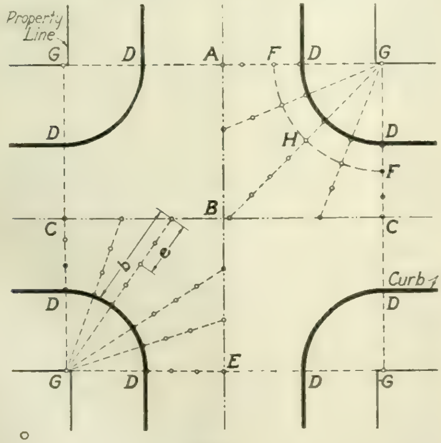

Fig. 1.

If the high point of the crown, between intersections, has been shifted from the center line to compensate for gutters of unequal elevation, the elevation of A, C or E cannot be found as described in paragraph (2). It can be found, however, from the grade between intersections. Then the high point in the crown must be combined smoothly with the intersection grades. If F is the high point in the crown, the elevation of H can be figured as in paragraph 6 and a uniform grade made from H to F.

Elevations between points on FF and the center line are then figured as described in paragraph 6 or as a straight grade, depending on whether points on FF are below or above corresponding points on the center line.

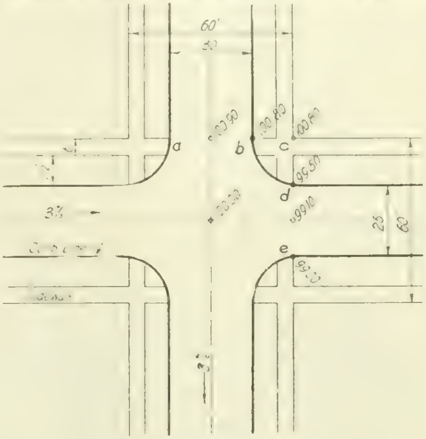

Fig. 2.

When the grade between centers of intersections is less than 3 per cent it may be carried through the block without a break, but when it is more it is best to flatten the grade through the intersection to 3 per cent, make a break at the property line (extended) and increase the grade through the block accordingly.

If the grade on center lines through intersections exceeds 3 per cent, it is nearly impossible to fit the sidewalk elevation to the curb elevation without excessive slopes on the cross walks.

For example, Fig. 2 shows an intersection with center line grades of 3 per cent. Curbs at A and B and at D and E have been given all the difference in elevation possible without making the pavement slope too steeply toward the lower curb.

Sidewalks should not be lower than the curb, so the elevation of the walk at C has been made the same as the curb at B, making a slope from C to D of 1.3 ft. in 11.5 ft. or an 11.3 per cent grade, which is dangerously steep. A wider pavement would increase this steep slope, so, even for the moderately difficult intersection shown, the center line grades cannot exceed 3 per cent.

When all elevations have been put upon the sketch of the intersection they should be carefully examined for inconsistencies. The fewer changes necessary in the field, after the grades have been once given, the less the expense to the contractor and the greater the respect accorded the engineer in charge.

Utah Counties Cooperate with Government for Topographical Survey.

With an appropriation of $3,000 made available on May 15 by the Salt Lake County Commissioners, approximately $7,000 of a required $10,000 has been raised for a topographic survey to be made in co-operation with the United States geological survey.

Through the efforts of Ralph R. Woolley, hydraulic engineer of the survey, $10,000 was appropriated by the Federal Government for topographic work in this state, the appropriation to become available when matched with a similar amount to be raised by the state or county. Utah County appropriated $2,500 and Tooele County $1,000. Other appropriations are expected from Weber and Boxelder counties to make up the required amount.

Selecting the Pavement for City Streets

Factors to Be Considered in Determining Paving Type, Outlined in Paper Presented at City Paving Conference, Philadelphia

By G. M. PINCKNEY

[illegible]

The first factor and the most important, in my opinion, is a thorough and comprehensive study of the traffic to which the pavement is to be put. A traffic census should be taken to determine the volume, density, character and speed of the traffic. The distribution of the traffic is also an important matter. The division of the traffic into motor and horse-drawn vehicles, what percentage is on steel tires, the percentage on rubber tires, the percentage of pneumatic vehicles and percentage of business vehicles are all factors which enter into the selection of a type of pavement. If there is a great deal of parking of vehicles on a street this also has a bearing upon the type of pavement to be selected.

Street Grades.—The next factor to be considered is the grade of the street. Streets with heavy or steep grades can never become main arteries of travel. The traffic conditions thereon, however, can be materially improved by the selection of a proper type of pavement. For instance: When a grade exceeds 5 per cent a very careful study must be made of the character of traffic using the street so as to provide proper traction. It is a good policy to restrict the use of smooth pavements such as asphalt and wood block to grades of 5 per cent or less. We have asphalt pavements, however, on grades as high as 7 per cent and they are giving satisfaction. No city street should be constructed to a grade above 10 per cent.

In connection with the selection of a type of pavement for a street where the grade is involved consideration should be given to the question of skidding. If the traffic on the city streets is to move without interruption a non-skid pavement should be provided.

Climatic Conditions.—The climatic conditions obtaining in a city should be borne in mind when selecting types of pavements also. In a city where severe winters are encountered pavements should be laid which will permit readily of the removal of snow, which will not be affected by cold, and which will not be unusually slippery when the temperature is low.

Pavement for "Quiet" Streets.—In selecting a type of pavement for a street upon which there are schools, churches, hospitals, dwellings and offices, noise is a most important factor, and quiet must be provided. Where manufacturing and industrial establishments are situated the noise element is not such a great factor. Quiet streets, so constructed that they will assure maximum comfort to brain toilers, are essential in a large city. Noise interferes with the health of persons who work with their brains, and it interferes also with the health of persons who having worked all day with their brains must sleep at night.

Effect of Zoning.—The zoning of cities into residence and business use aids the engineer very materially in the selection of pavements by insuring the character of the occupancy of the abutting property as well as the use of the street. The business interests in large cities have a tendency to concentrate into districts. For instance, in New York City in the Borough of Manhattan the insurance district, the financial district and the dry goods district can all be clearly traced, and the produce, butter and eggs, silks, woolens, cottons and yarn industries can be traced into districts. This helps materially in the selection of a proper type of pavement.

Pavement Durability.—A pavement in a city, in order to be satisfactory, must be durable. It must be durable because the repairing of a street seriously interferes with business, interrupts traffic and produces general inconvenience. Therefore, the more durable the pavement the less interruption to business, etc. In addition to being durable, a city pavement must be easily repaired, that is to say, it must be possible to effect a quick and prompt repair and one which will blend in harmoniously with the original pavement and be satisfactory in every way. The pavement which is not readily repaired, or a repair which has to be barricaded over any length of time, is not suitable for a city pavement.

Cost Factor.—In a large city, it is my opinion that the first cost of the pavement is not the determining factor. Where, however, there are several types of pavement from which to make a selection wherein all of the other factors are equal the cost then might be made the determining factor. The writer believes, however, that the use of local materials in so far as it is possible should be taken advantage of.

Paving Inspection

Viewpoint of Contractor Given in Paper Presented at Philadelphia City Paving Conference

By THOMAS S. MARTIN, 3rd,

of Benjamin Foster Co., Philadelphia

The first requisite for proper relations between the engineer and the contractor is clearly worded specifications. Every clause should be expressed in good English. Specifications which need constant interpretation and frequent appeals by the inspector to the engineer cause delays, and therefore loss of money to the contractor.

Co-operation Between Inspector and Foreman.—The contractor's foreman or superintendent, to be of any use, must be a man who can overcome obstacles and meet emergencies as they arise. He, therefore, is likely to resent what he considers constant interference with his work by an inspector who is not only young, and inexperienced, but perhaps undiplomatic as well. On the other hand where the inspector's suggestions and orders are given in a sensible way and with a real desire for co-operation, they ought to be received in the right way, for the foreman or superintendent who engages in constant disputes with the inspector may be wholly unfitted to bring about the co-operation which the contractor desires with his customers. Of course there are contractors who do not read the specifications before they bid. In other words, they do not really know what is expected of them, and only trouble can be expected from any such situation as this. But where the inspector takes the attitude that he is there not only to see that the job is done in accordance with the specifications, but to make the job go along quickly and smoothly, the relations between him and the contractor are bound to be harmonious, and without harmony no organization can possibly work as it ought.

Inspector's Interpretation of Specifications.—With regard to the inspector's interpretation of the specifications, it cannot be too strongly stated that all specifications must be interpreted with common sense. If he is supervising the laying of granite block pavement, he must realize that these blocks are not pieces of mosaic. To be unduly careful about the straightness of the rows, or the widths of the blocks in the rows or the wideness of the joints, and then not to see that the cement grout is properly mixed and placed is to show lack of knowledge as to where to make the contractor live up to a literal interpretation of the specifications.

This same idea applies to those above the inspector. If every time the engineer visits the job he talks about something that is wrong—especially if it is some small matter—and rarely says anything about what is right, he soon gets the reputation of being impractical, and he probably is. If that foreman or superintendent is worth anything at all, the job he is running is to him the greatest job there is, and to have someone find fault with some minor point discourages him and results in no good. Not that a man should be constantly praised, for that is surely not good, but a word of encouragement at times will often do more than fault finding to bring about a desire on the part of the contractor's foreman to do his best, which is surely what every engineer wishes. The contractor's superintendent or foreman should be led to look to the engineer as a man having superior knowledge along certain lines, and not simply as a kind of super-censor whose principal job is to find fault.

The Guarantee.—The subject of guarantee is closely related to that of inspection.

In the days past when the various types of modern pavement were being developed, and the knowledge of them and their behavior was not what it is now, a guarantee of 10 to 15 years might have seemed a good thing for the city or town to require. It enabled the engineer and the city authorities to put the responsibility of the success of the pavement on the contractor who, of course, charged in his bid for this service, although this fact seems to be frequently not realized, and is not fully realized yet. People in business can not give something for nothing. If they are expected to maintain something about the design of which they have had nothing to say, they have to be paid for this service. Contracting is a hazardous business, especially in these days of unsettled conditions, and all principal risks expected are covered by the careful contractor in making up his bid.

Long Term Guarantee a Maintenance Fund. A long term guarantee is nothing more or less than a maintenance fund. Let us suppose an asphalt pavement laid 10 years ago and guaranteed for 10 years. Who can foretell what the traffic conditions will be 10 years from now—or five years, for that matter. The street we are considering may have been designed for light or medium traffic but the neighborhood has become an industrial one, heavy trucks travel over it in size and numbers not dreamed of ten years ago. Yet the failure of that pavement, if the maintenance clause of that contract is carried out, will result in an expense to the contractor to which it is unfair to put him.

It ought to be recognized that if the engineer writes a specification giving in detail just how the pavement is to be constructed, and provides proper inspection of the work, he must take the full responsibility for the work and not make the public pay for his lack of professional knowledge and confidence in his own judgment, which they will surely do, because the contractor is compelled to consider the extra expense that he will be put to because of the long maintenance term in his contract.

Guarantee Practice in Various Cities. Just a few words as to the present practice of guarantees in a few places. The City of Buffalo, we are informed, still requires a 10-year guarantee on asphalt pavements. In New York City, the guarantee on all types of paving and repairing is 5 years, with the exception of granite block, which is for 1 year. In Philadelphia, where the pavement is paid for wholly by the city, it is 3 years on bituminous pavement, 1 year on granite block, and 5 years on vitrified and wood block. Where the pavements of any character are paid for in whole or in part by assessment bills the guarantee is for 5 years.

The specifications of the Pennsylvania State Higway Department, which are unusually complete and clear, do not require a maintenance guarantee; when the job has been accepted and has been paid for the contractor's responsibility ends. In other words, the State engineers take on themselves the professional responsibility for the work and the contractor is expected to do his part toward constructing the work as called for by the specifications. It is rather significant that these specifications, which I understand are regarded as a very good example of modern specifications, have eliminated the maintenance guarantee.

Careful Subgrade Preparation for California Road

A noteworthy feature of the Ballena-Julian concrete road now under construction in San Diego County, California, was the care taken in the preparation of the subgrade. This work involved three general operations in which three different shapers made of heavy timbers with steel blades and iron shoes running on the headers were used. The operations were as follows.

First, the roadway was plowed to full depth of the implement, 12 in. not being considered too much, and clods were broken up with a cultivator run diagonally across the roadway to cut down any ribs that may have been left. A Fresno was then used to cut the high and fill the low spots while the cultivating was continued. Then the subgrade was roughly shaped to cross section.

The subgrade was rolled while it was still dry to discover spots were settlement might occur, and these were filled while the shaper was being used. Rolling also helped to pulverize the clods and make the character of the subgrade uniform. Cultivating and rolling were continued until a uniform crown and desired grade were secured. When shaped it was cultivated with longitudinal furrows to prepare it for watering.

The subgrade was watered in sections of 500 to 600 ft., a large hose and high water pressure being used. Watering of a section was a continuous operation, the stream being directed into the earth in straight lines cross-wise of the subgrade, advancing 4 to 6 inches each time across. Watering was done preferably during the latter part of the afternoon and cultivation started the next morning. Rolling was resumed as soon as the subgrade was brought to the proper consistency, and continued until there was practically no more compression indicated under the wheels. When rolled down to within an inch of the final grade, the final cutting was done with the shaper resting on the headers. The shaper was drawn by the steam roller, and was weighted down by the subgrade crew riding on it. By means of a handle the shaper can be turned over and the excess earth cut from the subgrade dumped in transverse ridges, leaving the shaper ready for the return cut. A scratch template was used to check for depth, and the subgrade was again watered. In its final stage the subgrade was so hard that wheels of heavily loaded trucks made no perceptible indentation.

Unit Prices Michigan Highway Work, 1918-1921

An interesting comparison of prices for highway work in Michigan in the past four years was given by Mr. F. D. Messinger, Board Engineer of the State Highway Department, in a recent bulletin of the department. The accompanying table summarizes the average unit prices for the years 1918 to 1921:

Item of Work.	1918		1919		1920		1921	
	No. of contracts.	Average unit price	No. of contracts	Average unit price	No. of contracts.	Average unit price	No. of contracts	Average unit price
Clearing, acres	2	$58.00	16	$113.21	7	$88.02	12	$65.01
Grubbing, square rods	2	0.57	15	1.27	5	1.45	12	1.17
Earth excavation, cu. yd.	47	0.51	130	0.66	135	0.79	214	0.61
*Earth excavation, cu. yd.	..	...	...	...	26	1.01	98	0.82
†Earth excavation, cu. yd.	...	....	..	.	109	0.77	116	0.56
Rock excavation, cu. yd.	2	2.81	6	3.61	3	3.43	7	3.50
Sodding, sq. yd.	3	0.17	1	0.50	..	....	1	.05
12 in. encased tile culverts, lin. ft.		....	84	1.36	106	1.95	99	1.79
15 in. encased tile culverts, lin. ft.	..	...	43	1.87	70	2.65	69	2.22
18 in. encased tile culverts, lin. ft.	...	....	3	1.41	56	3.28	66	2.62
12 in. corrugated metal culverts, lin. ft.	10	2.13	20	1.93	3	2.34	26	1.83
15 in. corrugated metal culverts, lin. ft.	11	2.48	12	2.51	2	3.40	22	2.47
18 in. corrugated metal culverts, lin. ft.	28	2.66	3	2.16	1	4.45	34	2.18
1:2:4 concrete, cu. yd.	50	16.32	117	20.68	133	26.87	171	21.60
1:2½:5 concrete, cu. yd.		.	.	.	16	26.37	19	18.98
1:3:6 concrete, cu. yd.	46	13.43	106	19.96	114	24.24	130	19.68
Steel reinforcement, lb.	43	0.092	116	0.082	127	0.102	154	0.081
Concrete gutter, lin. ft.			2	0.66		.	...	..
Cobble gutter, lin. ft.	1	0.80	1	1.00	...	...	6	0.81
Curb and gutter, lin. ft.	2	0.59	2	1.21	2	0.80	2	0.79
Guard rail, lin. ft.	37	0.42	55	0.56	68	0.77	99	0.60
One course gravel surface, cu. yd.	.	..	3	1.32	12	2.78	3	3.05
Base course gravel surface, sq. yd.	...	....	...	....	7	0.56	17	0.46
Two course gravel surface, sq. yd.	30	0.59	51	0.91	60	1.04	69	0.77
Stone or slag-gravel surface, sq. yd.	5	0.78	11	1.35	5	1.06	4	0.90
Waterbound macadam surface, sq. yd.	.	.	19	1.22	2	1.88	1	0.92
Bituminous macadam surface, sq. yd.	...	..	2	1.06	4	2.05	1	1.95
Bituminous surface treatment, sq. yd.	...	..	.	..	2	0.155	6	0.09
Concrete pavement, sq. yd.	8	1.97	20	2.45	30	3.18	91	2.79
Bituminous concrete pavement, sq. yd.	1	2.10	...	....	3	3.33	18	2.96
Concrete base, sq. yd.	...	..	3	1.56	...	....	.	..
Brick on concrete base, sq. yd.	...	....	1	3.76	..	.	1	3.75
Bituminous concrete wearing course, sq. yd.	...	..	2	1.58	2	1.89	.	...
Bituminous macadam wearing course, sq. yd.	...	....	...	....	...	....	3	0.88

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*With paving contracts. †Without paving contracts.

The "average unit price" is the total price divided by the total quantity, the number of contracts not being considered. Contracts awarded to townships and counties at cost were not included.

Better Pay for Highway Engineers

A Report on the Compensation of Highway Engineers in Iowa Presented to the State Highway Commission by Sioux City Chapter, American Association of Engineers*

Report by [illegible] Seward, C. [illegible] and [illegible] Apple

The [illegible] engineer in charge of a highway program as the engineer of the state or county highway commission is charged with a great responsibility for the design of bridges, the preparation of road programs, road plans and estimates, the supervision of [illegible] of construction, the selection of materials of construction, the work of the contractors. In short, [illegible] of a large organization required to build the [illegible] which present day conditions require. He spends the taxpayers' dollar in road building. He is the man on whose efficiency rests the success or failure of the highway program and he is staking his professional reputation on the result. The state highway engineer and his staff of engineers must assume greater responsibilities, if possible, than engineers in other [illegible] engineers are al[illegible] and some [illegible] types of work because of the magnitude of the highway business and the experimental character of the work due to continually expanding traffic requirements.

Salaries of County Engineers in Iowa in 1921.

There would be hundreds of applications for the position of State Highway Engineer if the salary were only $2,500. As long as the public is willing to accept any kind of service it can fill all its places at any given salary. In elective positions in the state, salaries are not large, but we must take into account that men want these political positions for the glory and prestige, and they are held only for a short term of years after which a man may return to his business or profession and recuperate. The engineer, on the other hand, is underpaid in the same way, and this is his life work. Annual changes in personnel due to inadequate salaries ruin the efficiency of an organization and thousands of dollars spent in training men for their duties, are lost when the commercial field offers more attractive salaries.

The expenditures of past years are as nothing compared to those proposed for the years to come. The competition for brains and experience of superior value in planning and building highways and for talent in all the fields allied to highway construction is keen and intense. Unless we provide adequate salaries for engineers to handle this work we will find our organizations [illegible] at the time when construction expenditures are [illegible], and when the most efficient and capable men are needed. If we want our highway business properly administered we must make highway service attractive to professional engineers, we must recognize the common truism that we get what we pay for.

Some time ago the American Association of Engineers appointed a national committee made up of men of unquestioned professional and moral qualifications to draw up a list of salaries for engineers in state and county highway service commensurate with the responsibilities of the positions considered. The list of salaries for professional engineers in state highway service was compared with the salaries actually being paid today in Iowa, and a number of other representative states. The salaries recommended by the committee are not, by any means, extreme. The opinion of the committee, as to what should be paid to engineers occupying highway positions was tempered by a knowledge of the necessity of educating the public and public officials before any considerable relief could be obtained. Accordingly, the salaries recommended were lower than would be recommended for positions of similar nature outside of public service. It is worth noting that these salaries have been approved by the American Road Builders' Association and by the American Association of State Highway Officials.

The committee which prepared the salary recommendations consisted of A. N. Johnson, Chairman, then consulting highway engineer of the Portland Cement Association and now dean of engineering at the University of Maryland; S. C. Hadden, editor of Municipal and County Engineering; J. H. Prior, consulting engineer on public utilities, Chicago; A. R. Hirst, State Highway Engineer, Wisconsin; F. H. Newell, then president of A. A. E. and head of the department of Civil Engineering of the University of Illinois.

The corresponding highway members of the committee were Thos. H. McDonald, chief of U. S. Bureau of Public Roads; W. L. Basset, Bureau of Municipal Research, New York; W. D. Uhler, chief engineer, Pennsylvania Highway Department; A. B. Fletcher, state highway engineer of California; A. W. Dean, chief engineer, Massachusetts State Highway Commission; Clifford Older, chief engineer, Illinois State Highway Department; and H. F. Shirley, of the Highway Industries Association of Washington, D. C.

Three states pay their chief highway engineers an amount equivalent to the minimum salary recommended in the schedule. No state in the Union pays its engineers of construction, its engineer of maintenance, its office engineer, or its confidential inspectors as much as is recommended in the schedule. Only one state pays its first assistant engineer of construction the equivalent of the minimum salary recommended in the schedule. Although eleven or twelve states pay their assistant engineers the equivalent of the minimum recommended it is quite likely these engineers are performing the duties of higher positions and that were their title to exactly indicate their duties, they, too, would be found to receive considerably less than the recommended minimum.

The recommended salaries in the schedule were not established on a war time basis; they are not intended for a time when values are inflated.

We wish to bring out the fact that forty county highway engineers in Iowa who are, admittedly, underpaid are receiving salaries of from $3,000 to $4,000 per annum, while engineers employed by the highway commission on similar work, receive only $2,400 per annum.

We believe that the compensation now being received by highway engineers in this state is not commensurate with the duties and responsibilities involved, and that a higher schedule of salaries would result in better service by enabling the commission to retain men of suitable qualification and experience.

We, therefore, respectfully recommend that the Iowa Highway Commission adopt the "A. A. E. Salary Schedule."

Cost of Grading and Paving on Federal Aid Road Jobs.—Statistics compiled by the Bureau of Public Roads of the United States Department of Agriculture on 1,350 completed Federal-aid roads, involving 7,500 miles of road, at a total cost of $112,000,000, show that of the total cost, 21 per cent went into grading, 14 per cent into structure, 62 per cent into paving, and 3 per cent for engineering. These are the average figures for the whole of the United States, but there is considerable variation in different sections. In the Middle Atlantic States, where grading is not heavy and paving must be built for heavy traffic, the cost of the paving rises to 75 per cent and the grading and structures fall to 15 per cent and 9 per cent, respectively. In the Mountain States the problem is very different, much of the work being new construction with heavy grading, and the highest type of surface is not necessary. In this group of states the cost of grading amounted to 33 per cent, structures 20 per cent, and paving 42 per cent.

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*[illegible] of the report in Professional Engineer for May.

Developments in the Scientific Testing of Road Surfaces, Subgrades and Materials

Equipment and Methods Developed for Use on the Bates and Arlington Experimental Roads

The following accounts and illustrations of experimental equipment and tests on various roads are taken from bulletins received during the month of May from Bureau of Public Roads of the U. S. Department of Agriculture and the Illinois Division of Highways:

Bearing Power of Soil Determinator

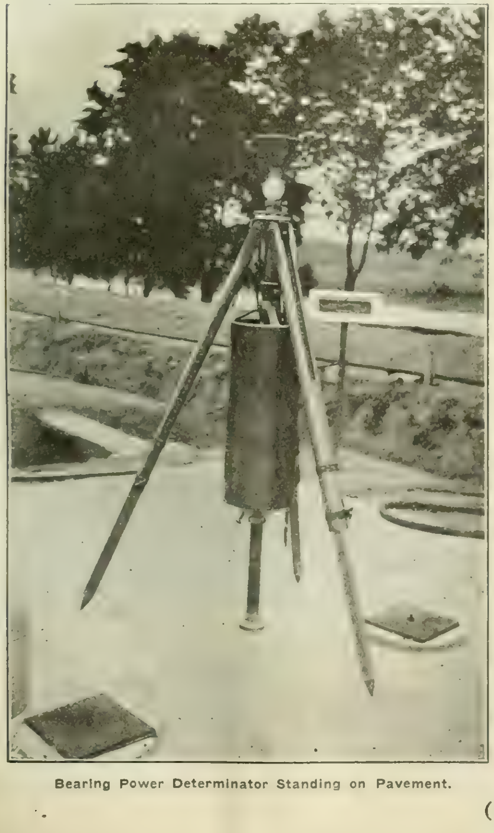
To measure and compare the bearing values of the various types of subgrade soils the Bureau of Public Roads of the United States Department of Agriculture has designed and built an apparatus which has promise of good results.

The apparatus is simple in design, light, easily built, and is capable of measuring the bearing value of almost any soil containing an appreciable amount of moisture.

It may be operated by one man with two helpers and offers a suitable means of securing valuable information as to the load-carrying capacity of subgrade soils before pavements are laid.

The general appearance of this apparatus is shown in the accompanying cut and it has only four separate parts, tripod, shot container with bearing foot, shot funnel and Ames dial. The load is applied by pouring measured quantities of fine shot into the funnel at regular intervals, while the penetration of the foot into the subgrade is indicated by the Ames dial mounted above the tripod head.

To operate the apparatus, the tripod is set firmly in the ground and the shot container with foot is brought to a truly perpendicular position as determined by the small level shown just above the shot container. By a slight movement of the bearing foot the direction of the load to be applied is made perpendicular to the subgrade.


Bearing Power Determinator Standing on Pavement.

The shot funnel is next placed in proper position at the top of the tube and the Ames dial clamped to the tube with the dial foot resting on the top of the tripod head and when the dial is adjusted to read zero all is ready for the test.

In the tests which the bureau is conducting at present the load is applied in increments of 1 pound per square inch every 10 seconds and the dial is read to 1/1,000 in. about 5 seconds after the application of the load. The penetration of the bearing foot under each load is plotted in the form of curves on cross section paper and the curves for the different soils are compared, taking into account the moisture content of each which is determined from a sample of the soil sealed in a glass jar at the time of the test.

Profilometer for Study of Surface Irregularities

Bearing Power of Soil Determinator

It has been suspected for some time that roughness in a road surface is objectionable not only from the point of view of those who travel over the road, but that it is also productive of damaging forces which affect the integrity and life of the road.

It is for this reason no less than for the accommodation of travelers that clauses have been inserted in modern specifications limiting the degree of roughness which will be permitted in the finished pavement. Such clauses, in fact, are inserted primarily with the protection of the road in mind, because the minor roughness which it is their purpose to limit is not particularly objectionable to traffic.

But though there has been a well founded belief that such roughness does add to the intensity of the destructive force of impact there has heretofore been no means of measuring the effect of it; nor has there been any instrument by which all the minor variations of surface level which make up roughness could be measured with accuracy.

Two instruments have recently been devised by the Division of Tests of the Bureau of Public Roads for the purpose of supplying this information in connection with the accelerated traffic tests which are being conducted under the direction of Mr. Clifford Older, Chief Engineer of the Illinois Division of Highways on the Bates Experimental Road. The two instruments are known respectively as a profilometer and an accelerometer.

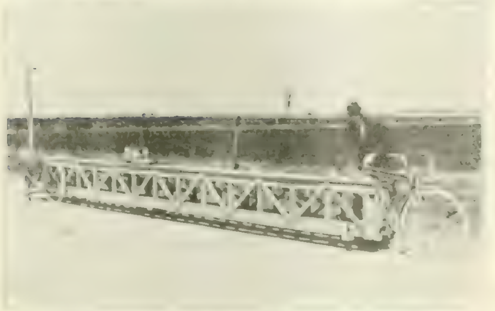
The profilometer, which is to be used for measuring roughness, has just been constructed at the laboratory of the Illinois Division of Highways. By means of this device the profile of any part of the road surface can be quickly and accurately obtained. It will be of particular value to all engineers engaged in highway construction since it affords a quick and simple means of determining if road surfaces conform to the degree of smoothness required by pavement specifications.

The apparatus consists of a straight edge or track 24 ft. long and a recording device which when drawn over the track records accurately and autographically the profile of the pavement beneath. The track as used on the Bates Road is supported by three bicycle wheels and consists of two wooden trusses 24 ft. long by 20 in. high with a 3-in. space between them. Four turnscrews, two at each end, permit of leveling the track at each set-up, while a piano wire under constant tension, stretched from end to end gives a datum for detecting any sag in the track.

The recording apparatus consists of an American straingraph to the pen arm of which is attached a rod connected with a brass wheel which rests on the pavement surface. The vertical movements of the small wheel caused by irregularitions in the surface are traced on the recording paper by the pen.

For drawing the recording paper over the truck a wire cable is used attached to each end of the platform and passing over a pulley at each end of the [illegible]. The pulley at one end is operated by a crank.

In addition to the autographic record of the profile the summation of the vertical movements of the surface profile can also be obtained from the profilometer by means of a special attachment which consists of a [illegible] long which receives the pen arm movement and rests against the recording wheel of a planimeter in such a way that the upward movement only is recorded. The summation of vertical ordinates shown by the attachment divided by the length of surface passed over gives an average ordinate which can be considered as a roughness factor of the particular surface.



Profilometer in Use on Bates Experimental Road.

This apparatus can be used to check up the smoothness of any length of pavement. As a first step levels are taken on points 18 ft. apart. The truck is then set over these points and the recording apparatus is drawn over it. When these points are plotted on the profile paper the records can be placed directly on the points thus giving a continuous and accurate profile of the surface for any required distance. On the Bates experiment this apparatus will be used to determine the roughness of the surface before it is subjected to traffic as well as the effect of the traffic upon the surface.

The profilometer will be used also, in conjunction with the accelerometer attached to one of the test trucks, for determining how roughness of the surface influences the impact of the motor wheel.

The accelerometer which was improvised by the Bureau of Public Roads consists of the recording part and case of an American strainograph, to the pen arm of which is attached a rod supporting a weight suspended between two compression springs. This device is attached by means of rods directly to the rear axle of the truck.

The theory of this device is simple. If there is no vertical acceleration of the axle the weight will not change its position with respect to the axle and the record will be a straight line. Any vertical acceleration, however, will cause the weight and consequently the pen to vary from a straight line and the greater the acceleration the greater will be the deviation from a straight line. This variation is a measure of the force which causes it and the force corresponding to any particular variation can be determined by calibrating the springs. Knowing this force and the mass of the wheel and axle it will be possible to compute the corresponding impact.

Having secured from the instrument the graphs showing relative impacts produced by different types of the surface and from the profilometer graphs showing the roughness of these parts of the surface a [illegible] by which the effect of the surface roughness on the impact of motor wheels can be measured with a fair degree of accuracy.

By means of the accelerometer it is planned to study the effects of surface irregularities on the rear wheel of a truck traveling at rates of 5, 10 and 15 miles per hour with no load and with 2½ and 5-ton loads. It will also be used in determining the increase in impact [illegible] the [illegible].

Arlington Experimental Road

A comprehensive program of road-building research and investigation during the coming season at the Arlington Experimental Station near Washington, D. C., is announced. Impact tests on pavements, subgrade studies and other experiments, which last year aroused much interest among engineers, will be continued as well as several other lines of work under way last year and new ones to be started.

Tests on More Than Thirty Bituminous Sections. Bituminous wearing surfaces are to be investigated to determine the reason for the formation of waves and irregularities and to settle mooted questions concerning the proper mixture and the proper mineral aggregates to be used in bituminous roads. More than 30 sections of different types of bituminous construction will be built. These will include mixtures of different mechanical grading and with different percentages of bitumen of several degrees of hardness. Sections are being constructed on a circular track about 600 ft. in circumference, the roadway being 22 ft. wide. On this roadway will be operated a 5-ton truck equipped with solid tires. The truck will be operated in a varying path so as to cover practically the entire width of the roadway and will travel at a speed of from 12 to 15 miles an hour for five or six months, or until some results are obtained leading to the solution of the problems involved.

Sixty-five Different Concrete Sections to be Tested for Resistance to Wear. There is considerable discussion as to what is the proper criterion to be used in selecting and judging concrete aggregates that will offer the greatest amount of resistance to wear. At the present time judgment is based on wear tests made in the laboratory and upon the compressive strength of concrete, also upon the structural strength of concrete beams constructed and broken in the laboratory. The comparison of the wear of concrete in actual use on road surfaces with the indications obtained in laboratory experiments is not wholly satisfactory.

To throw more light on this subject, a wear test is to be made with the conditions approximating those actually found on the road. This test will include about 65 sections of concrete wearing surface, each section being of a different quality of concrete, the qualities being varied by virtue of the different proportions in the mixture and amount of mixing water. These sections are to be constructed on a circular runway about 650 ft. in circumference, the runway being 4 ft. wide.

General View of a Part of the Arlington Experimental Station Showing Slabs for Impact Tests, Sections for Concrete Wear Test and Slabs for the Investigation of Moisture and Temperature Effects.

On this runway will be operated a specially constructed car with two truck wheels equipped with solid rubber tires and loaded to represent a truck. The car will be guided by small railroad rails to hold it in position, the power being applied by means of an electric motor to the rear wheel. This apparatus will be operated around the circular runway at a speed of probably 20 miles an hour. The test will involve the use of truck wheels equipped with different kinds of tires and will include the use of non-skid chains. A steel tired wheel will probably also be used to get the effect of an accelerated wear test.

The object of this experiment is to determine the relative wear of the different concrete sections when subjected to traffic equipped with different types of wheel, also to furnish a comparison between actual service conditions and laboratory tests. This test will be in operation continuously beginning some time in June.

Impact on Roads Studied.—In a rather elaborate series of experiments, the bureau has studied impact of trucks on roads, and has determined approximately the magnitude of impact force under different truck and road conditions. The effect of such impact on concrete pavements and several types of road on concrete base was studied and reported on last year. This series of experiments is to be continued and enlarged. Over 120 road sections or slabs have been constructed in duplicate series. One series is on a carefully drained dry subgrade; the other series is on the same kind of subgrade, except that it is kept wet and as nearly saturated as possible by means of an underlying drain tile and side ditches filled with water.

Slabs for Impact Tests. The Cylinders Are for Compression Tests Being Cured Under the Same Conditions as the Slabs.

The testing of these slabs will begin some time during the month of May and will be by means of a new impact machine now being constructed which stimulates the action of the rear wheel of a truck. On this machine may be mounted truck wheels of different sizes and weights carrying different kinds of truck tires. This apparatus may be so operated as to reproduce the different loading and equipment conditions of a large variety of trucks. The slabs will be hammered by means of this machine in the center, on the corners, and on the sides so as to obtain the relative strength under these different conditions.

Subsoil Investigations.—Subsoil investigations are being continued for the purpose of studying and investigating relative stability, moisture condition, and supporting value. Different methods of determining the bearing value of soils are also being studied, that is, as to whether small or large areas should be used in determining the relative bearing value.

Temperature and Moisture Effects.—The warping effect of temperature and moisture conditions on concrete pavements is also being investigated. Temperatures and movement are being recorded graphically on continuous charts. In addition to these temperature and movement measurements the pressures on the subgrade under the concrete slab are obtained by means of soil pressure cells. This investigation will give some definite information concerning the support offered by subgrades to rigid concrete roads. This investigation has been under way for some time and will continue probably for a year or more.

Subsoil Pressures.—The transmission of loads through different types of pavements to the subgrade is being investigated by means of soil pressure cells placed on the subgrade under the pavements. This test will also serve to show the relative support offered to brick and other types of block pavement by concrete bases and broken stone bases. This investigation has been under way for about one year and will continue for some time to come.

Federal Funds for National Forest Roads

The sum of $15,000,000 has been apportioned by the Secretary of Agriculture among 27 states, Alaska, and Porto Rico for the construction of National Forest roads and trails.

Of this sum $9,500,000 known as the "National Forest Highway Fund" is set aside for roads of primary importance to states, counties and National Forest communities; $5,500,000 constituting the "National Forest Development Fund" will be used for the construction of roads and trails needed for the administration and utilization of the forests themselves.

These appropriations, forestry officials state, will give a new impetus to the work of opening up vast tracts of valuable timber and areas of scenic beauty for the use and enjoyment of the American people. The development of roads and trails throughout the forests will aid materially in fire protection. At present there are large areas of trackless wilderness within the National Forests that can not be reached by trails. When lightning storms sweep over these inaccessible areas, heavy fire losses of public timber often occur.

Speed in reaching a forest fire, foresters say, is just as important in protecting the country's forests as is speed in city fire protection. But high speed within the forests means 4 or 5 miles an hour over a mountain trail. If no trail exists it is often impossible for the fire fighters to average more than one-fourth of a mile in an hour.

In the past construction of many urgently needed forest roads has been deferred for lack of sufficient funds. Much of this work can now go forward. The Forest Service estimates that eventually over $100,000,000 will be required to supply a thoroughly adequate transportation system throughout the 156,000,000 acres within the National Forests.

The distribution by states of the "National Forest Development" and "National Forest Highway Funds" is as follows:

State	National Forest Highway Fund, $9,500,000.	National Forest Development Funds, $5,500,000.
Alabama	$ 4,880	$ 5,799
Alaska	970,271	50,222
Arizona	598,189	280,722
Arkansas	70,365	72,573
California	1,460,871	703,822
Colorado	717,058	336,360
Florida	25,118	8,730
Georgia	13,355	20,347
Idaho	1,097,894	1,088,656
Maine	2,760	1,754
Michigan	3,638	6,220
Minnesota	60,929	65,621
Montana	878,886	574,615
Nebraska	11,065	11,159
Nevada	207,984	55,377
New Hampshire	35,294	24,276
New Mexico	158,258	219,652
North Carolina	27,856	16,984
Oklahoma	5,645	8,764
Oregon	1,157,109	718,555
Porto Rico	1,451	5,344
South Carolina	1,572	8,704
South Dakota	77,553	64,139
Tennessee	20,896	23,243
Utah	371,776	164,258
Virginia	26,140	46,512
Washington	708,133	602,889
West Virginia	6,051	14,602
Wyoming	479,000	267,101
Totals	$9,500,000	$5,500,000

Technical Photographers Form Society

The Technical Photographic and Microscopical Society was organized at a meeting held in the Chemists' Club, New York, on May 10. It is planned to hold a general convention of industrial and miscroscopical photographers in connection with an exhibition of photographic work, chemicals and apparatus to be held at the Grand Central Palace, Lexington avenue and Forty-Sixth street, New York, during the National Exposition of Chemical Industries, September 11-16, 1922.

James McDowell, of Sharp & Hamilton Mfg. Co., of Boston, was elected president, and Thomas J. Keenan, editor of PAPER, 251 West Nineteenth Street, New York, was elected secretary-treasurer. Annual dues were fixed at five dollars.

Inspection Work for Pennsylvania Highways

How Surveys, Plans, Contracts and Construction Are Handled, Outlined in Paper at Am. Soc. C. E. Symposium on Highway Transportation

By H. E. HILTS

Deputy Chief Engineer, Pennsylvania State Highway Department

It has been found in the Pennsylvania State Highway Department that, in connection with the construction of a large program of state highways, the work of the executive is that of an administrator and that the work at headquarters is simplified and systematized by the careful manner in which inspection work is handled on the construction contract. Mr. MacDonald has expressed the thought that inspection is not just inspection on contract work, and the speaker believes that all will agree that his views are conservative but, nevertheless, the inspector can many times reach decisions that will benefit the work of both the district office and the main office of a department. The design of highways is subject to standardization and work of this character can be systematized. Plans also can be carefully checked, but inspection depends on the man assigned to it; therefore, all inspectors should be selected with care.

Selection of Construction Inspectors.—The work of a survey corps can now be systematized and checked, but after the work of an inspector has been done, checks may be made, but errors are costly to correct. In Pennsylvania candidates for inspection work are not selected by civil service, the policy of "hiring and firing" being preferred. It is believed that all inspectors should be interviewed at headquarters before being employed. The candidate on being employed, is told that he should consider himself a servant of the public, and that as far as emoluments of office are concerned, he must also realize that the satisfaction of building a road that is a credit to the department and to the commonwealth, must serve, in his own mind, as additional recompense. He is told that as far as the department is concerned, he is not merely building Route Number so and so, but in the future the contract on which he is employed will be known as the road that Inspector "Smith" supervised. In other words, an attempt is made to appeal to the human element and arouse the candidate's ambition so that he will deliver a real job.

Inspection Preliminary to Surveys.—The inspection of construction is only a small part of inspection work. Preliminary to the making of surveys for the preparation of plans, the district engineers inspect existing roads, which they know will be improved in after years. In other words, every trip a district engineer makes over an unimproved road permits him to visualize re-locations or changes in roads, and in the spring of the year these trips are particularly valuable in the inspection of drainage conditions.

All construction plans are premised on careful studies of drainage, and an endeavor is made to locate both sub-surface and surface drainage structures so that they will answer not only the ordinary conditions, but also extraordinary conditions as developed during the heavy winter of 1919, when roads that had been constructed for years, gave signs of failures during the spring thaw. These inspection trips, as they respect drainage, should be summarized by adequate notes which can be interpreted by the men in the office, who are designing the road.

During 1921 Pennsylvania constructed 678 miles of highway, largely made up of the so-called durable types—sheet asphalt or asphaltic concrete on cement concrete foundations, vitrified brick on cement concrete foundations and one-course reinforced concrete. In carrying this program, the material situation was carefully studied during 1919 and 1920. Considerable time was spent during these two years, even during the construction of 257 miles in 1919 and 114 miles in 1920, in tabulating material supplies, both local and commercial, by counties and by states adjacent to Pennsylvania. The inspection of roads by district engineers is carried to a study of grade-crossing elimination prior to the issuance of the survey authorization.

Inspection During Preparation of Plans.—After a survey has been made of the line established by the district engineer, a preliminary inspection with the plans of the project at hand is made by the district engineer and a representative from headquarters and if the project is a particularly difficult one, this preliminary inspection is made on foot. At this time, it is decided whether the alignment chosen is the best, and in checking this feature, it has been the endeavor to teach the men that the laying out of the highway, from the viewpoint of economy, must be developed by a study of distance, of maximum and ruling grades that will suit traffic conditions, the elimination of unnecessary rise and fall, and of dangerous curvature. This does not mean that in highway work, the refinement used by the railroad engineer has been reached, because in many cases one cannot visualize or even approximately determine which of the previously mentioned features of construction is the most important, whether it is elimination of rise or fall, or curvature, maximum or ruling grades, or a study toward the elimination of distance. The traffic has changed so rapidly in the last 10 years that it would appear that even the present-day engineer would have to be the seventh son of a prophet in order to anticipate traffic conditions ten years hence. The checking of judgment by figures in establishing maximum grades, rise and fall, and curvature, which really amounts to the setting of business limits for economical expenditure of funds at this time, must be premised on anticipated traffic which the road will have to bear 5, 10, or 20 years hence.

Another type of inspection is that of determining the kind of surfacing material which is to be used, and it is felt that, in deciding this question, an inspection on the ground by the district office is most important, so that full data may be secured as to the availability of materials, the nature of the termini of the road, and the present and the anticipated traffic which the road will take.

It has been found that the selection of type should not be based on the first cost alone, but should represent an investment, particularly where bond-issue moneys are concerned, which will, in some measure, be available after the bonds have matured, this investment not only being made up of grading and drainage structures, but also of the surfacing material. The competition between types, where such competition is based on engineering judgment, is healthy and stimulates or results in lower prices, induced by more efficient business methods in the construction of the road.

Inspection to Determine Availability of Local Materials.—The preliminary inspection as carried on by the district engineer is made almost simultaneously with an inspection made by the engineer of tests or his representatives, who examine the availability of local construction materials, the matter of inspection many times requiring from 3 to 5 days on a 3 or 4-mile project. The representatives of the engineer of tests blast out ledges and dig test pits, so that representative specimens may be obtained, and the quantity of materials available may be determined. This work has proven to be of extreme importance. In 1919 there were only about 8 per cent of the contracts on which local material was used. In 1920, some local material was used on 28 per cent of the contracts, and, in 1921, there has been an increase in the use of suitable local materials, which has necessarily resulted in a lowering of the first cost of the road.

The mechanical testing of materials, in a well ordered department, is mostly by systematized routine, and the writer feels justified in stating that the most important feature of tests is their interpretation. Experience in his work is a fundamental requirement. The writer might illustrate by a comparison of the different kinds of stone found in Pennsylvania, which vary from coarse grained sandstones to heavy dense trap rock. There is no sand in many parts of the state, and it has been necessary to prepare sand artificially by grinding coarse and fine grained sandstones. Studies were made, which pointed to justification in using artificial sands and in using good sands in combination with relatively poor aggregates, these results having been reached only after the construction of a test road in which various types of materials were used in combination. Test specimens were studied during the construction of the road and compared with specimens taken from the road after it had been in service for a period of six months.

The writer has dealt with inspections made preliminary to surveys and during the preparation of plans. All these inspections have one objective, that is, to have the plans as nearly perfect and practical as possible, and to submit them to the contractor so that he may have full information regarding the roadway under consideration. Each contractor is given, on his proposal form, the estimated quantities as nearly as they can be determined and on a supplementary sheet he is furnished with the local materials which might be used in the construction work, and their location, with the provision, however, that no guaranty is given as to the continuation of quantity or quality of materials as sampled. It is found that the engineers of the department have used judgment in the preparation of all this material, but it is also suggested and recommended that the contractor, before basing his bids on local materials, should analyze the location on the ground and examine the test pits and the ledges.

The final field inspection also furnishes information on which to base the time limit on the contract. A 5 mile contract has been built by an efficient contracting organization, in as short a time as 70 days; another contractor not as efficient might have required 3 years in building the same project. It is endeavored, as far as possible by inspection in the field, to work out a conservative time limit for every contract.

Inspection of Business of Awarding Contracts.—Only the engineering phase of contract work has been considered in all the inspection details mentioned. Another phase, however, is the inspection of the business of awarding contracts. This has been accomplished in Pennsylvania by calling to Harrisburg for interview, each contractor who has been a low bidder. At this interview the assistant commissioner of the department discusses with him the matter of equipment which he contemplates using on the work, this discussion being premised on a list of the major items of equipment which has been carefully prepared by the engineers of the department. This list is prepared on the basis of the minimum amount that should be used in completing the work within the contract time, and it is thoroughly understood, by a gentlemen's agreement, that the equipment finally decided on at the conference will be used on the work. Furthermore, the contractor advises whether he owns the equipment, is going to buy new equipment, or is going to rent it. Careful attention is given, in the discussion, to the method of handling the work and as to the contractor's qualifications, based on previous experience in handling men, and as far as the labor situation is concerned, local or imported labor is discussed, and the establishment of commissaries is considered.

It has been difficult at times, during the past three years, to have materials delivered in sufficient quantities and with sufficient regularity to handle the construction work economically. Therefore, the assistant commissioner requires the contractors, during the discussion, to outline a fairly definite program, as to where they expect to purchase materials, so that the department in turn from its previous experience can determine whether materials will be forthcoming, so that the contractor will experience minimum delays. It has been found that this procedure is warranted, inasmuch as it may result in speeding up the work and in reducing the hazard of having to complete one season's contract during the following season, thus causing serious financial loss to the contractor as well as to the state, inasmuch as the new road will not be completed over the winter and spring months.

In order that contract work may be handled promptly and efficiently, every contractor must have financial resources and, in the interview with the assistant commissioner, he must furnish evidence that he is financially able to handle the work, not from a surety point of view, but rather from the point of view of ready cash or stocks or bonds that he can use to raise money, or lastly, from the presentation of letters from banking concerns which express confidence in his ability and their willingness to finance him in an amount equal to at least 20 per cent of the cost of the work. Following the usual practice, the contractor also furnishes a surety bond from an approved surety company in the amount of 50 per cent of the contract cost. The interview with the assistant commissioner is not at all one-sided, inasmuch as he endeavors to impress on the contractors the thought that 100 per cent work is being looked for and that plans and specifications are prepared to be followed, and, further, that, in order to obtain a 100 per cent job, the department and the contractor must give each other 100 per cent co-operation.

The inspection of materials is made at the source of supply, in order to protect the materialman and the contractor, but this inspection is only preliminary. Inspection is also made at the delivery point of the contract, but this can be considered only as preliminary, the final inspection of materials being as they go into the work. It is endeavored to foster high ideals in the minds of the men by proper instructions in readable, illustrated form. The men have been instructed at headquarters and at district office schools, and three of the universities in Pennsylvania have established short courses in which particular emphasis has been given to the tenets of contract law and specifications.

Cost of Surveys, Plans and Inspection.—Questions often have been raised as to the cost of making surveys, preparing plans, and inspecting contract work, and there is a lack of data in engineering literature on costs of this nature. Take about 25 contracts, which were available and on which tabulated costs have been completed; these jobs include those which have been finished rapidly and on which the plans were prepared quickly, as well as those which were studied for two or three years, and on which the contractor made slow progress, due to weather conditions, the non-delivery of materials, etc. It is found that the cost of these 25 contracts has averaged $524 per mile, for field and construction surveys; $175 per mile for the preparation of plans; and $891 per mile for inspection work; the total cost expressed in percentage of the contract price being 2.96. The cost of inspection and tests of materials has averaged about one-fourth of 1 per cent of the contract price of the road. In other words, the engineering costs have averaged less than 3¼ per cent of the contract price, and the speaker submits that this is cheap insurance to the taxpayers of the commonwealth, and at the same time, furnishes the department definite assurance that it has done its part in working out an efficient and economical method of handling contract work.

How to Pull a Tractor Out of the Mud

The following tricks of the trade of tractor operation are given in "The Nose Bag," a publication of the Allis-Chalmers Co. While presented primarily for farmers, the information is equally usable by contractors under similar conditions.

If you are watching carefully the land you are working, it is often possible to avoid miring down. The minute you feel your tractor sinking you must disengage the clutch to keep the drive wheels from spinning, and unhitch the tractor from the implement. Unless the spot is very wet and soft you can run across it without trouble. It is then necessary to have a chain, cable or rope sufficiently long to allow you to hitch the tractor to the implement and pull it through the bad spot. This method works well because the tractor wheels are on firm ground when pulling the implement.

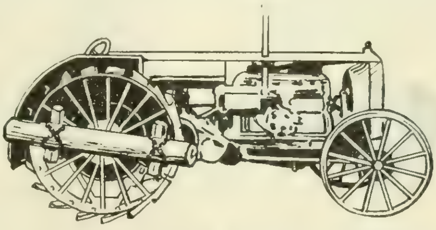


Fig. 1.

The most common method to use when the tractor is mired down is to take old boards, planks, posts, or in fact any available material, and place it under the wheels to give a better footing for the cleats or spuds. If one will use this method before the tractor is hopelessly mired it is often most effective and will help one to get out of a bad place in a short time.

There are times, however, when you may get your tractor mired in such a manner that the methods already described will not be successful. When this is the case you will save time and money by resorting to one of the following methods:

Fig. 1 shows a quick method of attaching a post or plank. Any available material of sufficient strength which is long enough to extend 5 or 6 in. over each rim may be attached to the wheel with a piece of rope, chain or wire. One piece is attached to each drive wheel, the ends of the material extending over the rim, will usually furnish the traction necessary to [illegible] the tractor to [illegible] In order to [illegible] the [illegible] or [illegible] the wheel [illegible] pieces of plank at least against the [illegible] as shown in the illustration. These [illegible] sufficiently to allow them to clear the [illegible] the tractor [illegible]

Fig. [illegible] shows a method of [illegible] of rope from wheel to wheel. This is an excellent method of getting out of the mire, but care must be exercised to see that the tractor

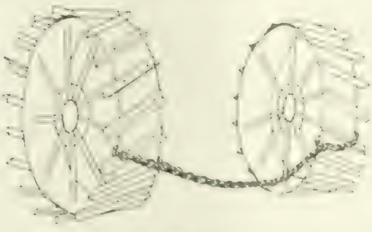


Fig. 2.

is stopped before it has traveled far enough to allow the chain, as it comes out of the ground, to catch on the draw bar.

The method shown in Fig. 3 can be successfully used when the tractor is badly mired. First shut down your motor and then shift into low gear. A long rope is then wound around the belt pulley several times and carried forward, ahead of the tractor, where a team is hitched on to the rope. The power of the team pulling on the rope is multiplied many times by being transmitted to the drive wheels through the gears, thus making it easy work for a team to pull out a tractor which is very badly mired.

Fig. 4 shows a method of burying a post or "dead man" ahead of the tractor. Two ropes are attached to this "dead man" and brought back and attached to each drive wheel. The tractor is then started and as the drive wheels revolve the rope prevents their slipping, thus enabling the tractor to pull itself out of the hole.

The suggestions outlined above apply where one is apt to encounter only an occasional bit of low, wet land. When the majority of the land to be worked is low and apt to be soft it is better to plan in advance to meet this condition by the use of extension rims.

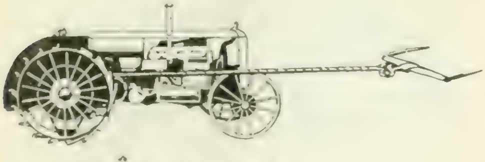


Fig. 3.

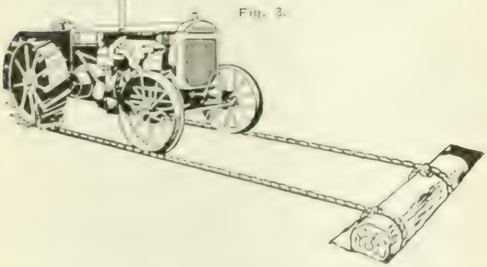


Fig. 4.

Boulevard and Parks Planned for Evanston.—A boulevard 100 ft. wide and 2 miles long is being planned in conjunction with additional parks for the city of Evanston, Ill. Both boulevard and parks are parts of a general civic improvement program under way. Daniel H. Burnham of Chicago is directing the work.

Mechanical Handling of Road Building Material

The importance of taking proper care of road building equipment was pointed out by Mr. R. M. Gates, chairman Materials Handling Division of the American Society of Mechanical Engineers, in an address at the last annual meeting of the Associated Pennsylvania Highway Contractors. We quote as follows:

The building of hard surface roads today is a manufacturing proposition. Here you take your factory to the point where your product is to be delivered. Even after you have moved your plant to the location, you are still compelled to shift it continuously, as the material is delivered. This method is the most trying, and invites greater hazards than any manufacturing enterprise.

The road-building shop, if we may call it such, is peculiar in that it has its machines and operations, also storage, along a narrow aisle in the "factory." Each operation is dependent upon some other operation, either ahead or behind it. The speed and quality of the work is also dependent upon the balancing up of the operators and operations. The personnel of the job controls the progress, for it is the men that man the tools that are responsible for the work. They, of course, must be properly selected and when at work must be supplied with proper tools and material to make the desired progress. The responsibility for this is with the management, and no place else.

Some gangs with inferior tools have shown marked superiority in workmanship and cost of construction over others with highest types of machines. The tools are a big factor when properly used, but it's the organization that counts.

To me, this organization controls the situation. It will use wisely or unwisely the tools or machines furnished it, and the result of the job depends upon the combined efforts of all. Each tool will do certain things and must have certain care. If it be neglected, overloaded or abused by misuse, the result is not the fault of the machine, but of the organization and the management. If through neglect or abuse the machines fall down, they may be a greater liability than a profit. If the gang is not competent to handle machines, it should be given only tools that it can profitably work with.

All manufacturers design and build machines not only for the work they are supposed to do, but also for a certain amount of neglect and abuse. The machines are not perfect and never will be, but the manufacturer has made wonderful strides. The operators, however, have not kept step with him.

Trained Mechanics Prevent Loss.—The tendency has seemed prevalent to employ low priced men, many with little experience, to do the actual building of road. With the advent of the more complicated specifications the management has changed to a much higher grade, until now we have some of our ablest engineers and business executives in this work. Many men on the job, however, are untrained and of very poor grade. This I feel is where the greatest mistakes are made.

Many superintendents and foremen refuse to recognize the fact that the limitations of tools depend upon the intelligence with which they are used, the work required to be within their power and that the proper care be given in their operation, lubrication and adjustments.

Today there are a number of contracts that do not have a mechanic on the job. Many intrust the care and adjustments to a man whose only previous experience was to run a "fliver." Bearings and gears break because concrete is allowed to collect day after day; grease cups are broken off and the hole filled with cement. Gentlemen, it is a wonder that there are not more breakdowns and greater losses.

Cost of Breakdowns. Most of the delays now, are, according to highway reports, due to breakdown of machinery. According to General Marshall in Washington, the average daily loss is approximately $500 per job on which operation is stopped. A fair share of these delays, I feel sure, could be avoided if the mechanics on the job were more competent.

Most manufacturing plants have trained men to operate machines and expert mechanics to make adjustments and repairs. But in your industry, where the conditions are many times more severe, you have poor labor as a rule for your operators, and often a master mechanic who is a local "Darius," whose whole experience has been with a hammer and a chisel, and who has fame as a tinkerer.

It can't be done at a profit. If you are going to limit your organization to cheap incompetent labor, you will limit your tools to the same as were used 20 to 30 years ago. Yes, even worse, for these high-priced material-handling machines will prove a lodestone on the job.

To get the best out of highly developed tools is to put men in charge of them that foresee breakdowns, who get maximum production every day. If you do this, you will have handsome returns, and the machines will surprise you with the way they will work.

My desire here is to make an earnest plea to you whose work is almost wholly one of material handling to be fair to yourself by being honest with the machines. If you are not, you will have to pay the price, to the tune of $500 per day.

Back Sloping with Grader and Tractor

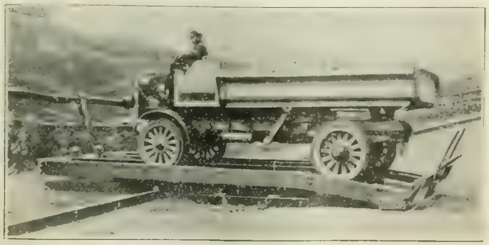
The accompanying pictures show an unusually interesting piece of work on a Federal Aid Project near Sisseton, S. D. The contractors were Jahnig & Davis, Britton, S. D., and the job, which was done in 1921, was the largest in the state, being 25 miles long.

All the earth was hauled, none at all being cast in. The illustrations show a 12-ft. blade Adams grader hauled by an Avery tractor. The contractor found this method of back sloping and sloping the sides of their hills to be a great deal cheaper than any other. The method produced even slopes and well defined shoulder lines, upon which the State Highway Commission was very insistent.

Two Views of Slope Work with Grader and Tractor.

A Truck Turntable of Improved Design

Important improvements mark the Blaw-Knox turntable illustrated herewith. The machine is notable for its compactness, as it occupies a space only 8 ft. wide, and as shown in the illustration is made so as to swing over a road form. This means that out-going trucks have free way to pass the turntable at all times and that the forms remain in place regardless of turntable operation

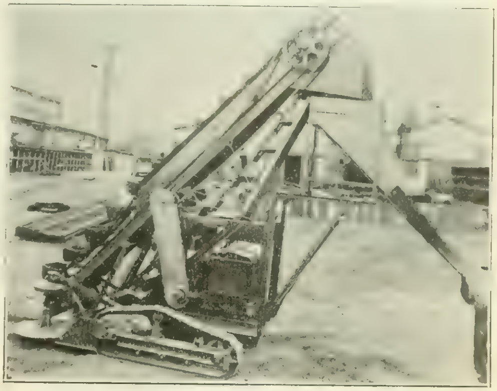


Blaw-Knox Turntable Overhanging a Road Form.

The turntable is mounted on skids which permit of its movement from place to place without damage to the subgrade. Ordinarily it would be pulled into position by an empty truck. The machine is intended for the handling of trucks up to 5 tons capacity. It can be operated by one man when carrying a 5-ton truck loaded with 4 yd. of material. This ease of operation is largely due to the fact that rotation is had upon a circular track with roller bearings. The design is both strong and simple.

An Enlarged and Improved Bucket Loader

The machine shown below, while not differing radically from its predecessors, is marked by several features which are distinct advances in the art of mechanical loader design and construction. The capacity has been increased from $1\frac{1}{4}$ to $1\frac{3}{4}$ cu. yd. per minute. The crawlers are increased both in length and in breadth. There is an improved arrangement for controlling the feed discs; and the standard Cotta truck transmission has been introduced, giving three speeds forward and one reverse.



Enlarged Barber-Greene Loader.

The machine is manufactured by Barber-Greene Co. of Aurora, Ill., and is strictly a one-man unit. The discharge height is 9 ft. 6 in. A hopper of variable capacity up to 21 cu. ft. is provided if desired. On standard equipment, the swivel spout is arranged to turn from the operator's platform.

An English Automatic Dump Cart of Two Yards' Capacity

[The following article and its accompanying illustrations are taken from the April 21 issue of "Engineering," London. We call especial attention to the tailboard operation—the board being shown in its raised or open position in the half-tone, and closed in the drawing.—Editor Engineering and Contracting.]

The automatic tip-cart illustrated in the accompanying figures is intended for use behind tractors, and will carry out all the work usually done by the ordinary farm cart. It will go anywhere that a cart will go, but carries a larger load, having a capacity of 2 cu. yd., and in virtue of its method of haulage, of course, travels more quickly. The cart should be of value for any of the purposes for which a farm cart is used, such as collecting roots, carting manure, etc., while it is clearly also applicable for any of the work for which horse-drawn tip-carts are used by contractors. The cart is attached to the trailer by two short shafts, and runs on caster wheels so that it closely follows the track of the tractor hauling it, and is readily maneuvered into awkward positions.

The tipping is carried out by braking the tip-cart wheels and reversing the tractor. The cart castor wheels, as will be seen from the figures, are carried on a bridle pivoted fairly high up on the cart body, and the result of applying the brakes to these wheels and reversing is that, instead of the wheels moving on the road, the body swings over them on the bridle until it reaches the tipping position shown in

Fig. 1. If the tractor is then started forward the whole arrangement will move, maintaining the position shown in Fig. 1, so that the cart is drawn along at the tipped level. If, then, brakes are put on the cart wheels and the forward movement is continued, the body will swing back until it is again in the traveling position as shown in Fig. 1. The whole of the operation of tipping and recovery of the body can be carried out in about 2 seconds. In general there is no tendency for the cart to tip when traveling, even when the brakes are off, but it is [illegible] that when encountering [illegible] against

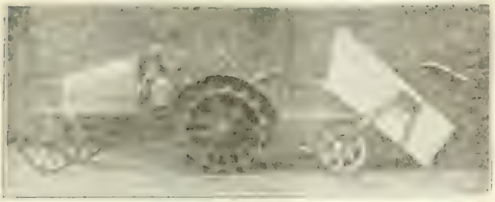


Fig. 1

a large stone or other obstruction on the road. This might cause it to tip, and to prevent this a catch is fitted which locks it in the traveling position until tipping is desired. This catch can be operated by the tractor driver without leaving his seat. The same thing applies to the cart brakes, and it will be clear that the combination is a one-man appliance. The tipping and recovery of the cart are done by the driver without leaving his seat.

It will be clear from the illustrations that the tailboard of the cart is automatically raised when it tips. The movement is carried out by the interaction of two toothed segments on each side of the cart, one member in each case being carried by the caster arm and the other by the arm

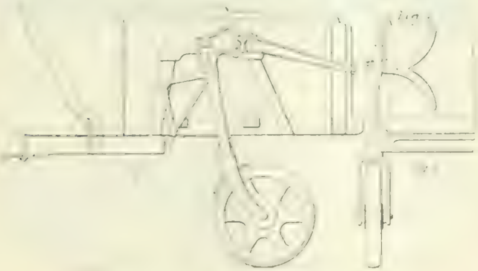


Fig. 2.

carrying the tailboard. As the body comes back to traveling position the tailboard is of course automatically restored to position at the back of the cart. Details of this tailboard arrangement are given in Figs. 2 and 3. The cart may be removed from the trailer by taking out a single pin, and, if necessary, several carts may be used with one tractor, so that the tractor has not to wait during the loading operation. If this arrangement is adopted loading stands are required to maintain the carts in position during loading. Such stands are supplied by the makers of the cart, Messrs. The West Kent Works, Ltd., of Westerham, Kent.

A One-Man Machine for Many Uses

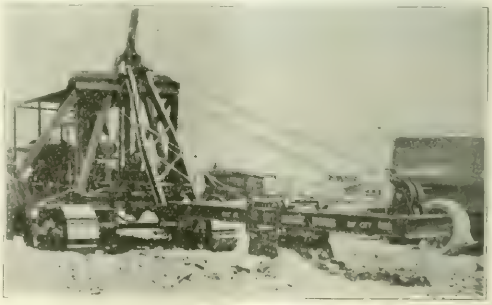
The accompanying illustrations show the skimmer scoop adaptation of a Bay City crane. The machine is strictly convertible and may be equipped as a crane with ½ cu. yd. clam shell bucket, electric magnet or other equipment. For use as a [illegible] yd. shovel type digger a change of boom is necessary. A third boom (the one shown herewith) converts the machine into a [illegible] yd. skimmer scoop. In addition to these uses, it may also be operated as a [illegible] yd. drag line.

As indicated in the pictures, the machine is powerful and of very solid construction. The skimmer is arranged for operation by either single or double line—a single line for fast operation in light or easy digging, and a double one for a slower but more powerful thrust in harder digging. The outriggers with which it is provided are not necessary for skimmer work, and are not used when the machine is so operated.

This unit is truly a one-man machine. It is equipped with

Bay City Skimmer Clearing Ruins of a Burned Brick Building.

three main drums, each on a separate shaft, and the operating levers are placed in front in such a position that the operator has a clear view of the work at all times. It is mounted either on broad tractor wheels or on crawling traction trucks. The engine is 4-cycle, 40-h.p., of the heavy duty

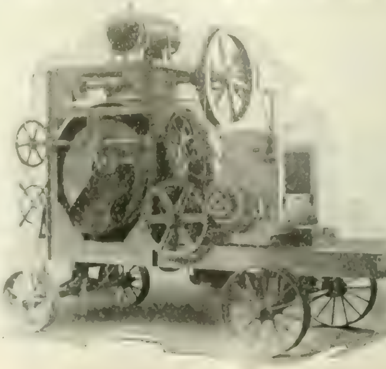


Skimmer Scoop at Work.

gasoline type, with fan-cooled radiator. Electric power may be substituted if desired.

Le Roi Power Unit with Smith Mixer

The accompanying illustration shows a No. 14-S, T. L. Smith Co., non-tilting mixer equipped with a Le Roi power unit. This unit is now fitted to both tilting and non-tilting



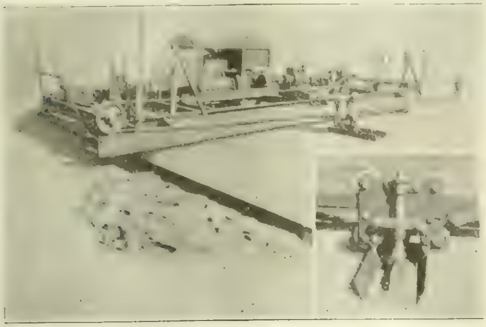
Discharge Side No. 14S Mixer.

mixers made by the Smith Co. It consists of a four-cylinder engine with radiator, magneto, carburetor, governor, fan and fan belt, fuel tank, air cleaner and an automotive type clutch. The weight is 850 lbs. The unit is marked by a very smooth delivery of power; and because of its automotive type may be operated by anyone familiar with truck or tractor engines.

A Trowelling Machine for Road Surfaces

A genuine trowelled finish, at once much cheaper and of better quality than hand work, is produced by a mechanical troweller recently brought out by the Austin Machinery Corp. for use with its concrete tamper.

The trowel carriage, accurately made and fitting the adjustable profile bar, a templet of the exact crown of the road required, travels across the road with a razor-stropping motion, at speed greater than that of hand trowelling. Two steel adjustable plows, one on each side of the 24-inch trowel proper, press down and work the surplus material. Controlled by two levers, a vertical lift is provided for the profile bar, and the stroke is made adjustable, so that it is possible either to trowel the full width of the road or work at any particular spot. At the back of the carriage is a mechanism which slightly tilts the trowel up in the direction of travel.

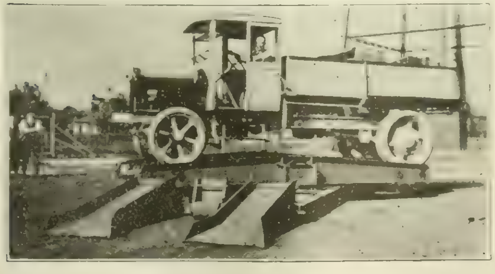

Austin Troweller—Close-Up and In Use With Tamper.

The troweller also provides a means for resurfacing any spots that may from any cause be disturbed by lack of sufficient concrete, footprints or foreign material.

A Turntable on New Lines

A table which satisfactorily and speedily turns trucks of any weight up to the heaviest, under full load, is shown in the illustrations below. This unit, known as the "Champion Automatic Truck Turntable," is manufactured by the Champion Engineering Co. of Kenton, O., and it presents a radical development in turntable design for heavy use.

The general character of the turntable is shown in the first picture. Its driving mechanism is simple, consisting of a set of gears connected to rollers on which the truck driving wheels act as a friction drive. The maximum wheel base which can be accommodated is 166 in., or 11 in. more than most wheel bases encountered. The table locks itself automatically, and the absence of a dead stop makes it safe, even for careless drivers.


Champion Turntable in Operation.

The total weight of the Champion turntable is 6½ tons; its width is 9 ft. and the swinging circle is 17 ft. 10 in. in diameter. The grade of the approaches is approximately 30 per cent, a slope which has been worked out as most suitable by careful tests with heavily loaded trucks. A turn of 180 deg. is made in from 15 to 20 seconds.

Among features to which especial attention is called is the very rigid base which makes operation completely independent of all surface irregularities of the road. It is built very solidly, and is claimed to possess many seasons' wear.

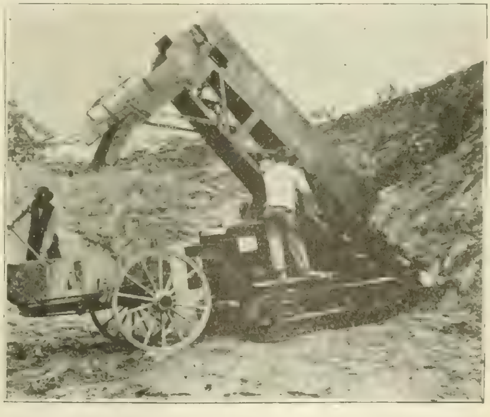
For moving short distances the table is provided with a set of transfer rollers on which it is raised automatically with the assistance of a truck. For long distance moving it is set on wheels which are supplied with the machine and is hauled as a trailer. The second picture shows it traveling a rough road.

Turntable Being Moved to Another Job.

Combined Digging, Screening and Loading Machine

The accompanying picture taken at the sand pit of the Essex Fells Co. of Essex Fells, N. J., shows in operation a path digging wagon loader made by the George Haiss Manufacturing Co. of New York. About two years ago the Essex Fells Co. installed a Haiss wheel type loader which handled about 200 cu. yd. per day. In the year following they supplemented the original machine with the one shown herewith, which handles about 250 cu. yd. daily. Each machine is operated by one man, and the cost with the larger one is about 9 cents per cubic yard.

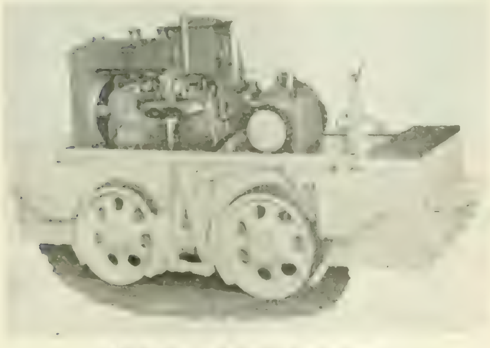
The pit has a face approximately 40 ft. high, and the consistency of the material is 75 per cent sand, 20 per cent gravel that will pass through a 3-in. ring, and the balance larger stones and boulders, some being 12 in. stones. The caterpillar machine requires no planking or the ground.


Haiss Path-Digging Wagon Loader at Work.

[illegible] chute where it is [illegible] the truck. [illegible] loading loose [illegible] it loaded [illegible]

Compact Industrial Locomotive

The Type G locomotive of the Atlas Car & Manufacturing Co., of Cleveland, O., is an extremely compact and dependable machine for light haulage service. It is complete in all details and is built to withstand severe use. Regular locomotive features are provided, such as hand-operated brakes with removable brake shoes, hand-operated sanders, structural steel frames and locomotive type bumpers. There is a throttle control similar to that on steam locomotives. The weight is about [illegible] lb., height 54 in. without cab, or 72 in. with cab, length over bumpers 94 in., track gauge 24 in. or wider, and width of locomotive over all 20 in. greater than track gauge for gauges less than 3 ft. For gauges of 36 in. or greater the width over all is only 10 in. more than the track gauge. The engine is 18 h.p., and the drawbar pull is [illegible] lb. at 4½ mile per hour.



Atlas Type G Gasoline Locomotive.

Personals

A. J. Drest [illegible] Streets and Alleys [illegible]

E. J. Stephenson has been appointed Chief Engineer of Public [illegible]

Harry W. Phillips [illegible] Brown, [illegible]

James L. Brown, [illegible]

Clarence W. Hudson has been engaged by the New Jersey State [illegible]

Henry G. Shirley [illegible]

B. H. [illegible] [illegible] Ill., [illegible]

Henry G. Shirley, [illegible] John Fisher [illegible]

Dr. Howard V. [illegible] [illegible] since 1911 and acting president since Dr. Gunsaulus' death.

Lorin Granger, Hillsdale, Barron County, Wisconsin, has been appointed patrol superintendent for the county. Mr. Granger will [illegible] the maintenance of [illegible] state and county highways. [illegible] patrolmen will be under [illegible]. Mr. Granger was awarded a prize last year by [illegible] newspaper for the excellence of his work.

B. H. Piepmeier, Construction Engineer under the Illinois Highway Commission, has been appointed to the position of chief engineer of the Missouri Highway Commission, at a salary of [illegible] a year. Mr. Piepmeier is expected to assume his new duties June 1. He is a native of Appleton City, Mo., a graduate of the engineering department of the Missouri State University, and for the past fourteen years has been connected in an official capacity with the Illinois Highway Commission.

Obituaries

John H. Dobbling, [illegible] of York, Penn., died April [illegible] from a fractured [illegible] the result of a fall. Mr. Dobbling was 71 years old. He was a nationally known railroad [illegible]

William R. Samms, County Surveyor of Bannock County, Idaho, died May [illegible] in Pocatello, Idaho, at the age of [illegible]. Mr. Samms had been engaged in engineering work in Pocatello since 1902 and served [illegible] terms as city engineer and 3 terms as county engineer.

John Lauson, president of the John Lauson Mfg. Co., New Holstein, Wis., died April [illegible]. He was [illegible] years old. He started the company which bears his name at the age of [illegible]. He is survived by his widow, [illegible] daughter, one sister and three brothers, one of whom, [illegible] Lauson, is identified with the Lauson Company.

Trade Publications

The following trade publications of interest to engineers and contractors have been issued recently:

Road Building Equipment.—An unusual pictorial display is contained in a 16-page publication in the style of a newspaper supplement issued by the Russell Grader Mfg. Co., of Minneapolis. It contains a great number of interesting views of road work and road-making equipment [illegible] together with views of the manufacture of such equipment and numerous pictures of [illegible] and unfinished roadways.

Heavy Duty Trucks and Features Thereof.—"Titan Trucks" is the title of a recently issued [illegible] of the Titan Truck Company of Milwaukee. The catalog not only treats of the [illegible] but describes [illegible] and is provided with high grade illustrations. Of special interest are the central double reduction rear axles and the [illegible] hoist.

Data on Safety Fuses.—The May issue of the "Hercules Mixer," published by the Hercules Powder Company, contains a very interesting article on the manufacture of safety fuse together with useful data for fuse users.

Paving Mixers.—Catalog [illegible] of the T. L. Smith Company, of Milwaukee, entitled "Smith Pavers," contains much interesting illustrated matter on paving mixers and other equipment manufactured by the Smith Company.

River Bank Protection—This is the title of a handsome bulletin issued by Woods Brothers' Construction Company, Lincoln, Neb., in which are described and illustrated many interesting river protection jobs. The publication also contains an account of the Burnell Self-Sinking Pile for [illegible] and bridge construction.

Road Building Machinery.—Catalog 15 of the C. D. Edwards Mfg. Co., Albert Lea, Minn., gives an illustrated account of a large line of road machinery such as graders, scrapers, plows, drags, concrete mixers and stump pullers.

Permanent Construction.—"Built to Endure" is the title of a remarkably handsome publication prepared by Phillip Koehring, illustrated in color by Wm. [illegible] and published recently by the Koehring Company, Milwaukee, Wis. On facing pages it contains pictures and short accounts of ancient and modern structures of great endurance. While its function is to advertise the use of concrete and of Koehring equipment, it is a true work of art accompanied by exceedingly interesting accounts of the structures shown. There are some eight or ten comparisons of things ancient and modern, together with other items of interest.

Self-Loading Scrapers.—Catalog No. [illegible], just issued by the Baker Manufacturing Co., Springfield, Ill., describes and illustrates a line of self-loading scrapers and gives much useful information on the subject.

Road Rollers.—"Galion Road Rollers—Motor and Steam" is the title of a very handsome catalog of the Galion Iron Works, Galion, Ohio, just off the press. The publication describes various Galion machines and their parts with numerous illustrations. The [illegible] Operated Scarifier attachment is of special interest.

Portable Conveyors.—Portable Scoop Conveyors of the Contractors' Type is the subject of an attractive and profusely illustrated folder just issued by the Portable Machinery Co., Passaic, N. J.

Excavating Equipment—Bulletin [illegible] X, just published by the Pawling & Harnischfeger Co., of Milwaukee, describes and illustrates in its 36 pages [illegible] excavators of various sizes and types including full [illegible] gas shovels, draglines, [illegible] and the other uses to be made with this machine, as the [illegible] scoop and pile driver [illegible] and such accessories as the [illegible] bucket, [illegible] chains and electric magnet. This Bulletin supersedes No. [illegible] X.

Industrial Notes

Amundson and Spafford Co. is the name of a road and highway contracting firm recently organized at Wisconsin Rapids, Wisconsin, by Louis Amundson and Howard Spafford.

The Bucyrus Company, South Milwaukee, Wisconsin, have under way at the present time extensive enlargements to both its plants at South Milwaukee, Wisconsin, and Evansville, Indiana.

These changes and [illegible] are planned to take care of their increasing volume of business and to enable them to [illegible] the South Milwaukee plant [illegible] the larger machinery is built, a new [illegible] under construction, [illegible] feet in length, and other extensive improvements are being made.

In the plant at Evansville, Indiana, which specializes in the manufacture of small [illegible] the machine and erecting shops have been considerably [illegible] to enable the company to handle its rapidly increasing business in these machines.

Waterworks and Hydraulics Monthly Issue

ENGINEERING AND CONTRACTING

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The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Quarries and Pits
(c) Streets
(d) Street Cleaning

Waterworks and Hydraulics—2nd Wednesday
(a) Water Works
(b) Irrigation and Drainage
(c) Sewers and Sanitation
(d) Waterways

Railways—3rd Wednesday
(a) Steam Railway Construction and Maintenance
(b) Electric Railway Construction and Maintenance
(c) Quarries and Pits for Ballast and Concrete

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures

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An Unjust Condemnation of a Public Utility Commission for Raising Water Rates

A good many editors of daily papers are prone to criticize any increase in rates granted to water works and other utility companies, especially at this time. Their arguments against increasing such rates are usually two: (1) Costs of living and other costs have been declining, hence it is incongruous to increase public utility rates; (2) Private corporations are not guaranteed 6 or 8 per cent on their investment, hence it is incongruous to give such a guarantee to public utility companies. Exemplifying this latter argument, we quote from the Bellingham (Wash.) American:

"Now in the state of Washington there are a lot of street railway, gas, water and electric properties, all built before the war, many of which have been notoriously overcapitalized, looted and mismanaged. The men in charge of these pay small attention to business—much to politics. You do not hear of any of these companies talking of their last year's losses—for they had none. In this state a kindly department of public works finds investments in public utility corporations sacred, and forces our citizens to pay these corporations a guaranteed income on their investments of from 6 per cent to 8 per cent per annum. Only yesterday the department issued an order which makes the citizens of Mt. Vernon pay sufficiently high water rates to permit the company to declare 8 per cent dividends. Many a business man in this city, struggling along to make both ends meet, must look longingly at the kind of business which makes the people insure them an income on their investment."

Without doubt, the editor who wrote this criticism believes that his statements are true. Accordingly, we suggest to him, and to other editors who believe similarly, that a letter be addressed to the leading merchants and manufacturers in their city, along the following lines:

Dear Sir: The public service commission of this state endeavors to fix rates for public utilities so as to yield them 8 per cent net on the money actually invested in the plant, thus aiming to prevent their earning more than 8 per cent in good times on less than 8 per cent in bad times. Will you be so kind as to tell me whether you favor having your business regulated by the state in a similar manner?

Yours truly,
— ————,
Editor.

We venture to predict that not one merchant or manufacturer in a hundred will, in answer to such a letter, express a desire to be thus regulated by a public service commission, even though his return on his investment were guaranteed to average 8 per cent. We go further, and predict that the owner of the Bellingham American would not vote for such regulation of his advertising rates as to limit him to 8 per cent on the actual cost of his plant.

The editorial article above quoted says: "You do not hear of these (public utility) companies talking of their last year's losses, for they had none." Perhaps not, but you do hear most of them talking of last year's deficits below 8 per cent on their investments. Lucky indeed has that public utility company been whose true net earnings have averaged 8 per cent during the past six years; that is, during the period when most private companies have averaged more than 8 per cent.

Although public utility commissions usually aim to give utility companies a return of about 8 per cent on actual investments in plants, it is a well known fact that the average net earnings of utility companies are less than 8 per cent. That this is so may be ascertained by any editor who will take the trouble to send a reporter to the office of the state public utility commission to examine the records on file there. Why is it, then, that so many editors draw upon rumor for their statements of alleged facts, when the facts are so easily ascertained?

We recall that certain daily papers in Seattle a few years ors were loud in their cry for municipal ownership of the street railway systems there. They wanted to keep down street car fares and prevent "capitalist [illegible]" from reaping such rich profits from Seattle [illegible]. Why are those editorial voices so silent on [illegible] profits now, now that Seattle has owned the street railway system for three years? They pipe another tune. The subject is too painful, in view of the Seattle municipal railway deficits. The truth is that the Seattle railway system never did yield even 8 per cent on the actual cost of the plant, and that jitney competition and other conditions brought the net earnings much below that. But Seattle editors were just lazy to get the readily ascertainable facts for their readers, and drew upon their imagination for the facts, with a result that they must now regret.

One Reason Why Most Civil Engineers Draw Small Salaries

Most employes blame their employers for failure to pay them adequately. Civil engineers are particularly given to this sort of complaining. Having spent four years in high school and four years in an engineering college "learning the profession," the average civil engineer feels abused because his salary is low.

It has been well said that a college diploma is not a bond from which its possessor can clip coupons. Rather it is—or should be—an announcement that its recipient has worked intellectually for four years, and is therefore eligible to perform similar work the rest of his life. But what percentage of engineering graduates thus regard their diplomas? Judging by the number that subscribe for more than one engineering periodical and buy many books, the percentage of engineers who study much after graduation is pitifully small.

About 12 per cent of the total members of the American Society of Civil Engineers subscribe for Engineering and Contracting.

Eighteen years ago when the writer was on the editorial staff of Engineering News he learned with amazement that only 14 per cent of the members of that great society subscribed for Engineering News. The "News" was at that time [illegible] years old, and was the leading civil engineering periodical in point of circulation; yet only one out of every seven of the leading civil engineers in America subscribed for the leading civil engineering paper!

This was an eye opener, and indeed the editor has not to this day been able to reconcile such facts with his belief in the worthwhileness of an engineering education. How comes it that so many men who have been taught to study engineering for four years, and at the formative period of life, almost cease reading engineering literature shortly after graduation? Doubtless there are many reasons. One of the most common reasons given by practicing engineers is: "I am too busy to read." Well, maybe that's one reason why you are paid so low a salary. Your employer may not be so dense as you think he is. When he notes that your library is meager and that you are seldom seen digging out information from engineering periodicals, perhaps he says to himself: "This man is a dead one, in spite of his college education."

It is noteworthy that the man who repeatedly goes to his employer with new plans for reducing costs usually comes to be highly regarded and well paid, provided the plans prove efficacious. It is also noteworthy that the men most prolific in new economic plans are usually great readers. Reading does not produce originality, but it does furnish most of the elementary ideas out of which new combinations or adaptations are effected.

Bearing upon this subject we quote Frank K. Walter, librarian of the General Motors Corporation:

"The need of books for men in industry is more acute now than ever. Whether it be in agriculture, in the factory, the shop or executive office, a knowledge of the best methods of producing more goods of better quality is imperative. Only in this way can the rising level of prices be met and the high cost of living be mitigated. More than ever before, the experience of all is needed by each. Waste, whether of time, energy or material, is little short of criminal under present conditions. Vocational help through the library is not only permissible but as necessary as many of the war activities in which the library played so prominent a part.

"Industrial corporations are realizing the need of such service and are liberally backing their own special libraries. The man who reads the technical book or the trade paper instead of resting content with what he learns from actual shop practice, is developing the initiative and individuality which have been the chief assets of American industry."

It is our belief that one reason why the average technical graduate is not much of a student of technical literature is to be found in the fact that he was not trained at school and college to seek for usable information in technical periodicals. For the most part, his formal education consisted in solving set mathematical problems, in performing set laboratory experiments, in listening to set lectures, and in reading facts collected by book authors from technical periodicals. Only to a very slight degree has he been required to collect, analyze and apply economic facts gathered from such periodicals by his own effort. Hence he graduates unhabituated to do the very thing that would be the most valuable to his employers, and therefore to himself, namely, to search for and apply the best economic methods. To cap the climax of erroneous teaching, he is usually given to understand that he should not attempt to master details, but should confine his study mainly to general principles. He is falsely led to believe that he should not exercise his memory, but only his "thinking powers"; when, as a matter of fact, the entire process of thinking is nothing less than a process of memory.

Water on Tap for Farm Houses

Farm homes are rapidly coming to have all the conveniences of city homes. An abundant supply of pure water always on tap in the home is perhaps the next great step to be taken by farmers in their march toward city comforts in the country.

Last summer the College of Agriculture of the University of Missouri started a unique educational campaign. Demonstrating trucks were sent around to teach farmers the advantages to be secured by installing small water works plants. Gasoline driven pumps were exhibited and farmers were shown how simple and relatively inexpensive is a small water works for supplying water by power to the house and barn. Special stress was put upon the boon of "water on tap" for farmers' wives. No more back-breaking rocking of pump handles, and still more injurious, carrying of heavy pails of water.

With a system of power pumping there would naturally go modern sewage disposal. Perhaps this last benefit should be emphasized more than all the rest, for farms are notoriously unsanitary. Even where the privy does not drain into the well, flies carry bacteria from the privy to the food in the kitchen and dining room. But with power pumping there will come modern bath and toilet rooms and septic tanks for sewage treatment. With these will come great relief from typhoid and other intestinal scourges.

Construction Work Booming

The following weekly summary was written by the editor of Engineering and Contracting for the Chicago Journal of Commerce:

Construction in the civil engineering field is reaching record proportions. This was foreseen five months ago by students of the subject, for in the last half of 1921 more than $900,000,000 of public works bonds were sold by cities, counties and states, as compared with $420,000,000 for each of the corresponding half years of 1919 and 1920. In the first quarter of 1922 the public works bond sales were $320,000,000, which was 50 per cent in excess of the sale in each of the corresponding quarters of 1919 and 1920.

Prior to the World War, the sales of public works bonds averaged about $110,000,000 for the first quarter of each year. Construction now costs about 70 per cent more than prior to the war, so that when reduced to pre-war prices, the sales of public works bonds in the first quarter of 1922 would build almost twice as much paving, roads, sewers, waterworks, etc., as in the corresponding pre-war periods.

Excluding buildings, the public works contracts awarded in the first three months of 1922 totaled $140,000,000; and the total in the succeeding two months (April and May) was almost the same. In other words, $280,000,000 of public works contracts, exclusive of buildings, have been awarded in the first five months of 1922.

Building contracts normally total about four times as much as public works contracts; but in the last five months building contracts have far exceeded this ratio, due to the unexampled boom in residence and apartment house construction. So, even after making proper allowance for the higher construction costs, there is now under way and projected more construction of public works and buildings than ever before in our history. Railway construction (both steam and electric) is very light, and will remain so until rate regulating bodies treat public utility companies much more liberally.

How a State Bureau Promotes the Installation of Waterworks and Sewerage Plants

The Bureau of Sanitary Engineering of the Maryland State Department of Health has three functions—regulation, investigation and development. The last mentioned has for its purpose the installation and extension of public water supply and sewer systems. This activity is considered of sufficient importance to provide therefor a major division of the bureau. How this development work is handled was described by Robert B. More, Chief Engineer of the State Department of Health in a paper presented at the Boston Conference of State Sanitary Engineers, from which the matter following is taken:

The division has an educational object in the large sense. It aims to promote, for individual towns or combinations of communities, the use of adequate water and sewer systems. It accomplishes this result by a variety of methods, which include the preparation of preliminary plans, of cost estimates, of methods of financing, and the presentation of these and other pertinent data to the communities concerned. The preparation of preliminary plans was found essential, in order to be able to present an intelligent case to the people, to picture to them the location of lines, to demonstrate practicability, and to prepare a fairly accurate cost estimate. By performing the above function, the bureau aids the popular mind in vizualizing the concrete system. It becomes easier then to have the town engage the private engineer to prepare complete plans and to obtain necessary bond issues. By stimulating, in the above manner, the installation of systems in many towns that would not otherwise act, the state aids rather than retards private engineering activity. At the same time information is obtained which permits of a more intelligent survey of the plans later filed by the outside engineer.

With preliminary plans at hand, the problem of arriving at a fair estimate of the cost of the improvement to the community is simplified. The importance of this second step in development work cannot be too strongly emphasized, since the factor of cost is usually the one which most influences local action. Often the public health argument has but little weight, while low capital and maintenance costs may carry the day. Abstract argument as to the desirability of adequate water and sewerage systems, seems to have little influence upon at least Maryland local authorities. Financial rather health factors almost always control.

Since popular minds are considerably more impressed by a dollar than a death, it becomes necessary for the state to adjust its talking points accordingly. This psychology cannot be ignored and, because of it, considerable thought has been given to the development of practicable and just methods of financing water and sewerage systems. Here again human nature predetermines and directs the line of action necessary. It has been made clear to us in most campaigns that the individual rarely is concerned with community welfare. Now and then, a utopian figure appears whose interests are communal, but most often the individual is interested in the cost to himself. On this account, an effort is made to work out, for each property holder in the smallest communities, and for standard units of property in larger places, the total annual cost which will result from the introduction of a new system. This can be done when there are available preliminary plans, detailed cost estimates, and information concerning the character, size and value of individual properties.

It may be of interest to point out that more effective results are obtained by quoting fire insurance rates before and after installation of a water system, than by mere reference in general terms to public health benefits. By the same process of appealing to the individual's pocketbook instead of to his heart, it is usually wise to keep the total cost of a project in the background, while emphasizing the low annual cost to individual property holders.

The plan of financing advocated for both water and sewerage systems need not be gone into in detail here. Its general principles are as follows:

Public and private benefits are separately considered. The payments of fixed and operating charges are kept distinct. The annual cost of the bond issue for constructing both systems is met by a combination of property tax, annual front-foot assessment, and house connection charges; the cost of maintenance of both, by meter service and water consumption rates. These various charges are distributed in such manner that the expense falling upon any individual, public or private, is as nearly as possible proportionate to the benefits which he derives.

It has no doubt already been made evident that the program of development here outlined is a conscious one and is the result of previous planning. It is not intermittent, but continuous and selective. Towns for intensive attention are carefully chosen, on the basis of population, sanitary needs, and financial status. Close study of each case from various viewpoints is carried out. The process of development is a deliberate one in which field and office studies and public presentation and discussion alternate and mingle. By devoting a separate division's activities to such work, assurance is had that the campaigns are well thought out and successive and, in this manner, discontinuous, haphazard excursions with general facts are avoided. Special knowledge of each local problem is acquired before and during each campaign. The method of attack in this way acquires at least a scientific aspect and the work should bear fruitful results.

Conventions of American Water Works Association and Water Works Manufacturers' Association in May

The 1922 convention of the American Waterworks Association, and the exhibition and meeting of the Waterworks Manufacturers' Association, held at the Hotel Bellevue-Stratford, in Philadelphia, May 15 to 19, have been praised by the more than 800 delegates and members who were present.

Many valuable papers were presented, some of which are given by permission in this issue of Engineering and Contracting. "Superintendents' Day," devoted to an exchange of experiences and ideas between superintendents, was a particular success and a pleasuce to all who attended.

Although recreation and amusements were provided, business was the order of the day, and almost the entire time was occupied with matters definitely pertaining to waterworks. In other words, the delegates showed their interest in waterworks affairs by treating their convention seriously instead of merely as a lark.

The character of the active membership of the A. W. W. A as stated by the chairman of the Publication Committee was most interesting. The classification was as follows:

		Per cent.
Engineers	569	43
Superintendents	288	22
Executives	248	18
Chemists and bacteriologists	87	7
Unclassified	134	10
Total active membership	1,326	100

The full membership is 1,608.

W. S. Cramer of Lexington, Ky., was elected president, and John M. Diven of New York and Abel Wolman of Baltimore were reappointed respectively secretary and editor.

Edgar Buttenheim of New York was elected president of the Waterworks Manufacturers' Association, and John A. Kienle, 25 W. 43rd St., New York, Secretary.

City Prepares Tablet for Tourists to Purify Water.—Going motoring or resorting this summer? The Chicago health department has prepared calcium hypochlorate tablets for rendering suspected water safe and thus avoiding the danger of typhoid infection. They may be obtained by Chicagoans at room 713, city hall.

Prevention of Tastes and Odors Due to Microscopic Organisms

History of New York's Problem, Completeness of Cure and Harmlessness of the Treatment, Told in Paper Presented at the Convention of the American Waterworks Association in May, 1922

By WILLIAM W. BRUSH,
[illegible] Water Supply Department [illegible]
[illegible] of New York City

If a group of water works men were to be asked the question, "under what conditions should a water works superintendent take action to prevent tastes and odors from microscopic organisms in a supply under his jurisdiction?" there would be a difference of opinion, and it may be helpful to set forth some facts which have a bearing on the determination of the answer to this question and then submit the answer which these facts seem to warrant.

Early Experiences on Croton Supply.—The knowledge we have of the microscopic organisms common to water supply is of comparatively recent date, and it is not surprising to learn that when the Croton water developed a very disagreeable taste and odor in 1859, or over sixty years ago, that there was general alarm about the wholesomeness of the water supply. Drs. James R. Chilton and John Torrey, two of the eminent scientists at that time, were engaged by the Croton Aqueduct Board to investigate the cause of the taste and appearance of the water. Dr. Chilton, who was a chemist, reported that there was nothing from a chemical viewpoint to indicate any pollution, and both he and Dr. Torrey concluded that it was due to a microscopic organism, Dr. Torrey stating * * * "we are warranted in concluding that the recent offensive condition of the Croton water was owing to a rapid and abundant growth of a microscopic conferva-like plant, which abounds in a volatile odorous principle, soluble to some extent in water. * * * I have not yet satisfied myself as to the origin of these little filaments whether they are the entire plant, or once constituted a part of a more complex alga. * * * It is a plant of short duration, and should it reappear another season, the probability is that it will not annoy us long. Very likely more or less of it occurs every summer, but this is the first time that it has been offensively brought to our notice. * * *"

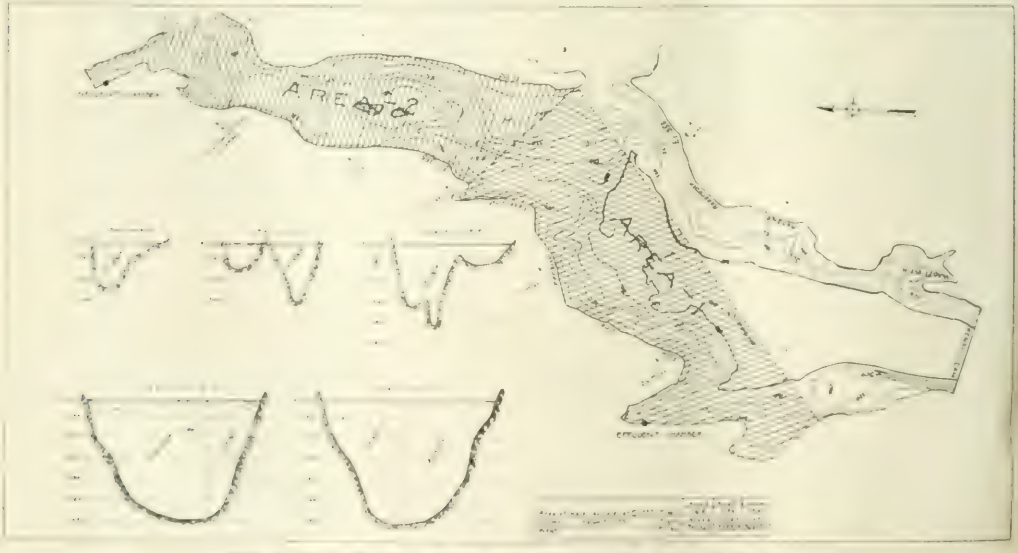
No remedy was suggested in the report submitted, except for the householder to use a filter, followed by passing the effluent through charcoal.

Alarmist Rumors.—Thirty-seven years later general knowledge on this subject had not materially increased, and when early in August, 1896, the Brooklyn supply developed a most disagreeable taste and odor with a whitish color, there was universal complaint, and much alarm on the part of the consumers. The allegation was persistently made that sewage was the cause of the trouble, and that the water supply was dangerous. I well remember how those of us in the engineering corps at that time were mystified as to the cause and the remedy. Aeration was the process most frequently suggested as the probable method of relief. The health department of the then city of Brooklyn advocated the cleaning of the ponds and flushing out of the mains.

Diatoms Revealed as a Cause of Trouble.—An investigation made by Dr. Albert R. Leeds of Stevens Institute very quickly showed that asterionella, one of the diatoms, was the actual cause of the trouble, and that this organism was most prevalent in the largest of the three basins of the low service distribution reservoir, which is known as the Ridgewood reservoir. After determining the presence of asterionella, as well as several other organisms, Dr. Leeds continued his investigations, which started on September 4th, and did not end until February 15, 1897. His conclusion was that the combination of surface and well waters in the Brooklyn supply was favorable to the growth of the microscopic organisms, especially asterionella and similar types, that the growth was stimulated by the basin in question being lowered to less than half the 20-ft. depth, in July, that there was no remedy except excluding light from the water, and he recommended covering the reservoir at a cost of over one million dollars. The reservoir was not covered, but a by-pass was built around the reservoir.

These two instances of trouble in the New York water supply, due to presence of microscopic organisms, have been cited to show how little was then known about the microscopic organisms in their relation to the water supply. One very important development of the Brooklyn trouble was the establishment of the water supply laboratory at Mt. Prospect with Dr. George C. Whipple in charge, Dr. Whipple having been Dr. Leeds' principal assistant in the Brooklyn investigation.

Introduction of the Copper Sulphate Treatment.—About



Map of Kensico Reservoir Showing Area Treated with Copper Sulphate seven years after the Brooklyn trouble, Drs. George T. Moore and Karl F. Kellerman gave the results of studies and experiments they had made on the germicidal effect of copper sulphate, and in September, 1905, there was a symposium on "The use of copper sulphate and metallic copper for the removal of organisms and bacteria from drinking water," held before the New England Water Works Association, at its annual convention. While copper sulphate was found to be unsatisfactory for bacterial removal, it was the first chemical to be successfully used on a commercial scale for the destruction of microscopic organisms. In 1905, and also since then, conflicting results were reported by those using copper sulphate for this purpose, but the weight of evidence shows this chemical to be an effective agent to destroy microscopic organisms. Since 1904 copper sulphate has been used to treat the distribution reservoirs, where necessary, and since about 1906 has been applied to small areas of shallow flowage in the various Croton reservoirs, about 15,000 to 30,000 pounds being used annually for the latter purpose.

The Completeness of the Copper Sulphate Cure.—In December, 1919, the copper sulphate was successfully applied to the Kensico reservoir to destroy a growth of asterionella, the volume of water treated being estimated as 11,500 m.g. This reservoir has been treated with copper sulphate four times since 1919, the last treatment being in April, 1922, and in every case the result sought has been accomplished. About 6,000 pounds of copper sulphate is introduced, using a boat, as indicated in the illustrations. The weight of copper sulphate passing into solution is about proportional to the water area treated rather than to the volume, and the effect of the greater dilution in the deeper sections of the reservoir is evidenced by the less destruction of the microscopic life. The water flowing into Kensico reservoir from the Catskill aqueduct was successfully treated by automatically feeding copper sulphate into the flowing water, although some years before we had apparently failed to destroy aphanizomenon by feeding a solution of copper sulphate into the new Croton aqueduct at Croton lake. The evidence from several aqueduct treatments seems to firmly establish the effectiveness with which the microscopic organisms are killed by the copper sulphate when introduced into the aqueduct flow. The two aerators, which are located at Ashokan and Kensico reservoirs, respectively, and through which the Catskill supply is normally sprayed into the air, have been found to have a destructive action on the more fragile of the microscopic organisms, the cause of such action being believed to be the violent treatment to which the water is subjected in passing through the aerators. The organisms are mechanically broken up and some of the weaker species fail to again develop below the aerators.

Chlorine as a Taste Remover.—The addition of chlorine to a water containing microscopic organisms has been generally found to increase the taste and odor, and it was therefore a surprise when in January, 1922, we found that by increasing the dose of chlorine the organisms were destroyed, and the taste removed. This discovery was made when tests were conducted to try to rid the Catskill water of a most objectionable taste caused by from 50 to 100 units of Synura per c.c when the water was treated with a relatively small dose of chlorine. The smaller dose of chlorine killed some of the Synura and released the disagreeable oil contained by these organisms, whereas the larger dose attacked and neutralized the oil released by the destroyed organisms, as well as destroying the organisms. It was further found that when the organisms were first either wholly or partially destroyed by the use of copper sulphate in the aqueduct, that subsequent treatment of the aqueduct flow with chlorine would remove the taste from the water with a much smaller dose of chlorine than that required when the water had not been previously treated with copper sulphate. The amount of chlorine required with or without prior copper sulphate treatment was too small to cause a chlorine residual taste in the treated water. In general, a net increase of 0.1 of a part of free chlorine, as shown by the orthotolodine test on the raw and treated water, was sufficient to give the desired results. The orthotolodine test on the treated water is made about thirty minutes after the chlorine is applied.

Water Free from Chemical on Reaching Consumer.—Some persons have expressed the fear that the copper sulphate treatment would have the effect of dosing the consumer with copper sulphate to an injurious degree. During this past winter while copper sulphate was being fed into the aqueduct at Ashokan at the rate of two pounds per million gallons, and the water was being delivered directly through the aqueduct from Ashokan to Hillview reservoir, a gallon and a half sample of water taken at the efflux of Hillview reservoir was evaporated down and the concentrate subjected to the most delicate copper tests without revealing the presence of even a trace of copper. The time of flow through the aqueduct is about thirty-five hours, and there is two days' supply in Hillview reservoir.

Kensico Aerator with Screen Chamber in Back Ground Where Chlorination Plant Is Located.

With the evidence now available of the successful destruction of microscopic organisms with either copper sulphate or chlorine, or a combination of these two substances, we hold that the water works superintendent can no longer consider the taste due to microscopic organisms as a visitation which cannot be controlled, and that his consumers have just cause for complaint if he fails to apply the remedy or remedies which have been successfully used elsewhere. A generation

Auto Truck for Operating Valves and for General Utility Purposes

The Dean Emergency "Shut-Off Truck" consists of a 1922 model Reo Speed Wagon chassis fitted with improved valve operating take-off. This is a special transmission permanently attached to the chassis, arranged to carry square valve operating keys of different lengths. All three forward and reverse speeds are available for operating.

On each valve in the zone of operation is attached a position indicator, which indicates the exact number of turns the valve is open. This indicator is applied to the valve without any alterations whatever, and takes the place of the valve nut. The operating end has a standard 2-in. nut to suit both truck and hand wrenches.

On the dash in front of the driver is the automatic cut-off indicator having an illuminated dial and adjustable numbers. The numbers on this dial are set to correspond with the numbers on the dial of the valve position indicator, after which the clutch is let in through, say—the second speed of the car. The valve completely closes, and the engine automatically stops. It is impossible to jamb the valve, and for further protection the cut-off may be set to stop a few turns from full closed position.

The automatic cut-off operates also when opening the valve.

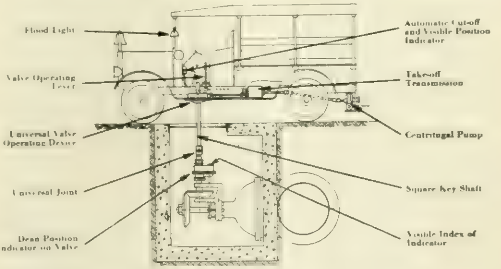

Flood Light
Valve Operating Lever
Universal Valve Operating Device
Universal Joint
Dean Position Indicator on Valve
Automatic Cut-off and Visible Position Indicator
Take-off Transmission
Centrifugal Pump
Square Key Shaft
Visible Index of Indicator

Diagram Showing Dean Truck Operating Valve.

By the aid of special universal joints, the vertical key shaft may be as much as 10 in. off center. An adjustable shear coupling in an accessible position is provided for protecting the valve stem.

A special low head centrifugal pump is provided under the rear of the body, driven by the transmission and provided with clutching and de-clutching device.

Underground Leakage and Its Relation to Mains and Services

Some Chicago Tests Described in Paper Presented at Philadelphia Convention, American Waterworks Association

By THOMAS F. WOLFE

One of the most convenient ways of expressing underground leakage in flow lines and distribution systems is to say it is so many gallons per day per mile of pipe or is so many gallons per day per foot of joint. Either of these figures is a fair indication of the efficiency of the transmission system only when there are no service connections to it. As soon as other means for water to get away are introduced, it is absolutely unfair to report or consider leakage as a function of the length of the main. Unfortunately, a better system does not readily offer itself because of the way leakage figures are arrived at. It is also unfortunate that the method of arriving at the amount of water lost in transmission involves so much guess work, because the lack of accuracy is responsible to a great extent for the fact that large water losses are so easily tolerated. In determining the amount of water getting away underground, the usual way is to account for all that is fairly measurable and then to ascribe the remainder to leaks. This involves considerable estimating and the net result as far as unaccounted for water is concerned, is nothing more than an estimate and on account of its unreliability, is not taken as seriously as it should be. In fact many water works men have come to look upon a large underground loss as a legitimate expense and consequently, to disregard it. In reality, there is small excuse for this condition because it is a fact that pipe can be laid so that it will be almost absolutely tight and if proper material and workmanship are used, there is no reason why the pipe cannot remain tight indefinitely.

In looking over water works statistics, it is not at all unusual to find many systems reporting losses of from 20 to 50 per cent of the water pumped. If this were true of those cities and towns where water is still sold on a flat rate basis, it might be ascribed to waste within the premises. As a matter of fact, such is not the case and many towns that are 100 per cent metered are unable to account for the entire pumpage without charging off a considerable percentage to underground losses. Possibly, all leaks cannot be eliminated, but a more serious consideration of the reason for leaks will at least greatly reduce the percentage of unaccounted for water.

Loss Due to Services—The thought that services are responsible for a large part of the water loss is not at all new, but it may be worth while to consider some accurate data pointing out the truth of this statement. Tests of parts of the underground system in Chicago made either by the writer or under his direction, give some interesting data in this connection. A test was made on the Stock Yards in Chicago, where it was comparatively simple to measure the total flow in the district under test and where practically the entire consumption was metered. The Stock Yards occupy an area of about one mile square, the eastern half of which is occupied mostly by cattle pens and is not supplied with city water. The remainder of the Yards is closely built up with packing plants where great quantities of water are used. Every service in this entire district except those supplying fire engine houses and public drinking fountains is metered and with the exception of a few ¾-in. services supplying elevated stations and isolated buildings, are of cast iron. In other words, this might be considered as a system free from service leakage, as the services themselves are constructed in exactly the same manner as the mains.

In conducting this survey, the mains carrying water into the Yards were shut down, with the exception of two 24-in. mains, one carrying water from the Twenty-second St. pumping station, the other from the Sixty-eighth St. pumping station. This created a number of dead ends and in order to avoid any danger from a limited supply in case of fire, a man equipped with a valve key was stationed at one of the fire engine houses within the limits of the Yards, with instructions to operate such valves as would increase the supply in case of fire. It so happened that during the period of the test, no fires originated in this territory; consequently, the valve arrangement was not disturbed. Pitometer taps were installed on each of these two supply mains and traverses very carefully run. All meters were read at the beginning of the test and the reading repeated at the end of the run and the daily rate of consumption established from these readings. According to the pitometer, the rate of consumption varied from a minimum of 6,960,000 gal per day to a maximum of 24,100,000 gal per day and the pressure from 24 lbs. to 37 lbs. The daily rate of consumption was plotted on a curve and the average daily rate computed. This was found to be 14,562,000 gal per day. The rate as shown by the meters was 13,782,000 gal per day. This leaves 780,000 gal per day to cover the following items:

Service to three engine houses, gallons per day	21,600
Two continuous drinking fountains, gallons per day	11,100
Hydrant leakage, gallons per day	*35,100
Water used from fire hydrants for street washing, gallons per day	10,000
Meter slippage, estimated at 2[illegible] per cent, gallons per day	366,000

*Based on average hydrant leakage found over the city.

which leaves 2.28 per cent of the total flow into the district unaccounted for. This figure indicates that with service pipe leakage eliminated, the amount of unaccounted for water is negligible.

Some Chicago Tests. We will now consider tests made on various streets in districts where conditions are different; that is, instead of an all cast iron system, we have a cast iron main and service pipes of other material. For the past five years, it has been the practice in Chicago to test each street for leaks prior to laying pavements. Not only are the tests made, but the leaks are located and over 92 per cent of the water found getting away in these streets has been stopped. This intensive leakage survey naturally brought to light the exact nature of the leaks. The streets tested can be considered average cases because in some of the mains and services were just laid, while in others, the pavements to be laid were replacing other pavements that had been worn out and the mains in these streets were from 25 to 70 years old. The tests are conducted in the following manner:

The section of main to be tested is shut down and all services shut off at the roundway at the curb. A 1-in. meter (or where the section is large, a 2-in. meter), is then by-passed around one of the closed valves through a 2-in. hose connected to 1-in. corporation ferrules installed on either side of the closed valve. If any leakage is indicated, an aquaphone is applied to a shut-off rod on each roundway and, as a rule, if the leak is any place on that particular service or on the main near the service, it can be easily heard. With experience, a man can tell about where a leak is by the relative loudness of the sound on adjacent services. If there are no services on the main, or for some reason the location of the leak cannot be determined as described above, a 1-in. earth auger is used to bore a hole down to the main itself. An aquaphone applied to rods in these holes will pin the leak down to a very small space. This method obviates digging numerous test holes in order to determine leak locations and has been used quite successfully in paved streets where the only opening in the pavement is that caused by driving a bull point through it. If the leakage is particularly difficult to locate, the main is cut in two and patent plugs similar to those used by plumbers in testing house drainage systems are installed in place of the pipe cut out. The water getting away in the section between the meter and the plug is then measured and in this way the section in which the leakage occurs, is located. In cases where the valves are not located in such a way as to make it possible to isolate the section desired, the main is cut at the limits of the section to be paved and these plugs used.

Results of Chicago Tests. During the year 1921 78½ miles of streets have been tested in this way and 1,091,000 gal per day of leakage measured; 1,070,990 gal per day or 99 per cent of the total leakage has been stopped. Of this amount, 92,000 gal per day was stopped by abandoning main. This main lay under street car tracks in downtown street and because of dense traffic, it was cheaper to lay new main. The remainder of the leakage was divided as follows:

Service pipes, gal per day	648,878
Joints, gal per day	65,161
Hydrants and valves, gal per day	259,751

The hydrant and valve leakage is excessive because in spite of ordinances to the contrary, hydrants are subjected to considerable abuse because of being used by building, paving and sidewalk contractors and others for construction purposes. The service pipe leakage of 648,878 gal per day or 60 per cent of the total underground loss was found to exist mostly in wiped joints. This figure on service pipe leakage is somewhat lower than it should be because of the fact that prior to making these tests, it is customary to cut off all wrought service pipes and replace them with lead service pipes. It is impossible to estimate how much additional leakage would have been measured had these rusted out wrought pipes been included in the survey, but as most of these pipes are in bad condition, it is reasonable to suppose that this figure would be materially increased. It should also be borne in mind that this includes only that part of the service pipe leakage between the main and the roundway and that leakage in these pipes between the roundway and the premises is not included.

From these figures, it can be seen that less than 7 per cent of the leakage is charged in any way to the main and none of this is due to leaks in the pipe itself. If the total leakage in these streets were reported in gallons per day per mile of pipe, it would be 14,000; whereas, the actual leakage in the main itself was 830 gal. per day per mile of pipe, or less than is often specified for new pipe. For the entire period of five years, 350 miles of pipe have been tested; 7,038,000 gal. per day of leakage measured; and 6,510,000 gal. per day or 93 per cent of leakage stopped.

The oldest main tested since this system was adopted was a 12-in. cast iron main laid in State St. in 1852. This main is part of the first main laid in Chicago after the use of bored logs was discontinued. The section of this main tested was 1,500 ft. long and was found to be absolutely tight. There were only three services off of this main and they were all cast iron. A 6-in. tap made for the purpose of connecting a hydrant to this pipe made it possible to inspect the interior as well as the exterior of the pipe and there was very little evidence of corrosion. It is not known what the original thickness of this pipe was, but the thickness at present is greater than the present Class "C" pipe.

As stated in the first part of this paper, a scheme of reporting leakage in complete distribution systems better than now used, is not readily offered, but at least this can be done. When leakage is reported as so many gallons per day per mile of pipe, it should be noted whether or not this includes leakage from services. The figures mentioned above would indicate that it would be more fair to say the leakage in a distribution system is so many gallons per day per service than it is to say it is so many gallons per day per mile of pipe, as the services were shown to be responsible for ten times as much leakage as was the pipe.

Hydrant Flow Survey in Detroit as a Guide to Reinforcement and Improvement of Distribution System

In 1920 a hydrant flow survey was undertaken covering the entire city, and about five months was required to complete this work. The object sought was to determine at all points the amount of water available for fire protection, and to do this the fire hydrants were divided into 1,500 groups of four each, and the amount of water discharged from three hydrants of each group was measured while the residual pressure was observed at a central hydrant. The discharges of the various groups were reduced to a 10 lb. basis; or, in other words, the discharge from each group was computed from the readings taken in the field to determine the amount of water available with a residual pressure of 10 lbs. These readings on the 10 lb. basis were posted on maps and the low areas were determined by inspection and used to determine the lines that should be laid for reinforcing the distribution system. Now that pipe has been laid reinforcing nearly all of the low discharge areas, arrangements have been made to make a second hydrant flow survey covering the entire city.—Report of the Board of Water Commissioners of the city of Detroit, Mich., for the year ending June 30, 1921.

Meterage.—Approximately 85 per cent of the services of Washington, D. C., are metered. The consumption during the past three years has averaged about 63,000,000 gallons per day, the maximum day's pumpage, which occurred on June 24, 1921, being 73,177,000 gallons.

The water department of Norfolk, Va., which is under W. H. Taylor, director of public works, with Charles H. Bliven as superintendent of city distribution, averaged in daily consumption for the past eighteen months some 11,300,000 gallons, the maximum for one day being about 13,500,000 gallons

Causes of Failure in Cast Iron Pipe

Quality of Iron as a Contributing Factor Suggested in Paper Presented May 18, at Annual Convention of American Waterworks Association

By F. A. McINNES,
Division Engineer, Public Works Department, Water Division, Boston, Mass.

In Boston, during the past 12 years, 19 failures of cast iron water pipe, 16 in. to 48 in. in diameter, have occurred, nine of them due to settlement upon an unyielding support, three to accident (in two cases blasting, and in the third case the operation of a public service corporation), two to freezing, one to imperfect casting, two to demoralization of metal in "bad ground"; in two cases no reason for failure was apparent. As usual, the fatal rigid bearing was the greatest offender. Eternal vigilance, expressed in unremitting inspection on the part of the water department, will alone minimize the danger from this cause in city streets. The pipe may be originally laid in a safe location, yet disaster may follow from the subsequent construction of sewers, conduits, subways, etc., under or adjoining it. All the failures of this kind mentioned above were due to settlement upon structures built after the pipe was laid, and all might have been avoided had reasonable care been taken to provide the necessary clearance around the pipe.

It is not my intention to discuss the damage resulting from electrolysis, bad ground, improper filling, undue external loading, settlement, etc., nor to go at length into the imperative necessity that cast iron pipe be well made, properly laid and carefully protected from adverse conditions after being put in service; much might be written on these points but I will leave that task to others, and propose briefly to call attention to a probable cause of failure neither so much discussed or so appreciated; I refer to the quality of the pipe iron.

Quality of Pipe Iron as Cause of Failure.—This vital feature has not been sufficiently safeguarded in our specifications which require the test bars to support a center load of 1,900 lb. (N. E. W. W.) or 2,000 lb. (AM. W. W.) and to show a deflection of 0.3 in. before breaking. The weak spot in these requirements lies in the fact that no direct connection is made between the loading and deflection with the result that in many cases the test bars do not show 0.3 in. deflection until the load is in excess of 1,900 or 2,000 lb., oftentimes largely in excess. Two thousand, one hundred and eighty-three test bars broken by the Metropolitan Water Board of Massachusetts during the past nine years give the following results:

3 bars showed .18" deflection at 1,900 lbs
5 bars showed .19" deflection at 1,900 lbs
35 bars or 1.5% of total number showed .20" to .21" deflection at 1,900 lbs
380 bars or 18.0% of total number showed .22" to .24" deflection at 1,900 lbs
229 bars or 10.5% of total number showed .25" to .28" deflection at 1,900 lbs
437 bars or 20.0% of total number showed .28" to .30" deflection at 1,900 lbs
905 bars or 41.5% of total showed less than .30" deflection at 1,900 lbs
456 bars or 21.0% of total number showed .31" to .34" deflection at 1,900 lbs
490 bars or 22.5% of total number showed .35" to .37" deflection at 1,900 lbs
136 bars or 6.0% of total number showed .38" to .40" deflection at 1,900 lbs
3 bars showed .42" deflection at 1,900 lbs
2 bars showed .43" deflection at 1,900 lbs

These results evidence metal of widely different quality, with a test bar deflection of 1,900 lb. ranging from .18 to .43 in., we may safely conclude that the iron varied from "very hard" to "very soft"; omitting the extreme cases, the deflection at 1,900 lb. ranged from .22 in. to .37 in., a condition far from satisfactory.

Water pipe iron, to secure the required resiliency and the necessary strength, should show a test bar deflection of approximately 0.3 in. at 2,000 lb., with an increased deflection of approximately .03 in. for each increase in load of 200 lb. above 2,000 lb.

The Permissible Sulphur Content.—The question naturally arises, "Why not specify the composition of the iron, stating just what percentage of the different elements will be allowed, as is done in the manufacture of steel?" There are practicable objections to this course based on the differences in ores and use throughout the country, of the necessarily different composition of these and [illegible], on the practical difficulty of making such a provision effective, on the possible undesirability of specifying both physical characteristics and composition of metal etc. The writer, however, believes that the permissible sulphur content of iron should be specified, with this provision together with a [illegible] relation between flexure and breaking load fixed in the test bar requirement, a long step forward towards uniform and satisfactory iron will have been taken.

It has been the practice of the Boston Water Department to analyze the metal in a broken or defective pipe, and the following determinations represent some of the results obtained over a period of approximately twenty years, many other analyses entirely above suspicion having been made in the same period:

[illegible]

Analyses of Iron.—Six breaks occurred between Oct. 19 and Dec. 5, 1906, in a 48-in. supply main of the Boston system, laid in 1880, following an increase in working pressure of 15 lb. The analyses of the iron in these cases were as follows:

	Sil.	Sul.	Man.	Phos.	C. C.	G. C.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.08	3.56
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

In St. John, N. B., 1916-17, one of the two 24-in. mains supplying the city failed several times, as it had been in the habit of doing at intervals in the past. The pipe was cast in England many years ago. The following are analyses of the metal in the broken pipe in three cases:

	Sil.	Sul.	Man.	Phos.	C. C.	G. C.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.80

The following analyses of a 24-in. main broken in the Hartford, Conn., system in 1921, has come to my attention:

	Sil.	Sul.	Man.	Phos.	C. C.	G. C.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Some of these determinations can safely be termed "horrible examples", witness the Boston 48 in. with C. C. .04 Sil. [illegible] and the Hartford 24 in. with C. C. .03 Phos. 1.86; one of these, the St. John 24 in., is in the freak class; the remainder, particularly those in which the sulphur content is abnormally high, warrant the conclusion that the quality of the iron was a contributing if not the direct factor in the failure of the pipe. The broken pipes were cast in main pipe foundries throughout the United States with two exceptions, namely, the St. John 24 in., which was made in England, and the [illegible] broken in 1917, which was cast in a small jobbing foundry in Boston. As a rule, two specimen pieces, taken from different parts of the broken pipe, were submitted for analysis and in no case was a substantially different result obtained from the bell and spigot end of the same pipe.

Salaries of Engineering Graduates of University of Nebraska.—The attempt which was made in last year's News Letter to secure engineering salary data for statistical purposes was partially successful. The highest number of reports received from any one class was fourteen. From this it varied all the way down to one. The older classes in particular were least responsive. [illegible] greatly with the number of years after graduation and therefore because of the small number of [illegible] the points on the average salary curve [illegible] of 15 years [illegible] to a considerable extent. [illegible] salary plotted against years since graduation rises from $2,000 to about $[illegible]. As it was, the [illegible] made above were made from [illegible] replies.—From the [illegible] News Letter to Graduates of the College of Engineering, University of Nebraska.

Light Weight Cast Iron Water Pipe

Experiences with cast iron water pipe used under pressures higher than allowed by current specifications were outlined by Mr. C. E. Inman of the Warren, O., Water Department in a paper presented at the Philadelphia convention of the American Waterworks Association. Mr Inman stated that the experiences covered many years' work, beginning in 1885, as foreman, supervisor of construction, and as superintendent in a number of different and widely separated cities. We quote from his paper as follows:

The weights of pipe used in those cities were fixed by engineers, or in some cases by the writer, and speaking generally those weights fall below the weights in the association's specifications as the following table will indicate:

	Weight per [illegible] length bells
6-in.	[illegible]
8-in.	[illegible]
10-in.	56.17
12-in.	[illegible]
14-in.	[illegible]
16-in.	106.75
18-in.	126.67
20-in.	[illegible]
24-in.	[illegible]

Lake Shore Foundry were putting out pipe under their standard weight for
6-in. of 33 ft
8-in. of 42 ft
10-in. of 60 ft
12-in. of 75 ft

Comparison of the above weights with the present A. W. W. A. specifications shows that some are even lighter than Class "A." In each town or city where this weight pipe was used, the pressure was always run up to 150 lb. per square inch on the completion of the work and in one city the pressure was increased every day at noon to 120 lb.; this was continued for 25 years. In this particular city, as well as in a number of other cities, there has never occurred, as far as the writer has been informed, but one failure on account of light weight pipe.

The plant in the city of Warren, O., was built in 1887 by Samuel R. Bullock & Co. It comprised 12 miles of mains and since then 46 miles have been added. The original pipe compares with Class "B," while many miles of the pipe as added from time to time was even lighter than Class "A," yet all has stood the test of years of service with a domestic pressure of 60 lb. and fire pressure of 100 to 120 lb., sometimes more when called for and in all these years only one pipe burst and then the gauge went over 150 lb.

In 1909 the works were appraised and showed over 2,000 tons of pipe. Now supposing the next heavier class of pipe had been laid for the sizes and mileage, at the date of the appraisal it would have added approximately 500 tons. This quantity at present quotations, say $40 per ton, would increase the cost $20,000 and for the period of time from 1909 to 1922, or 13 years, the interest compounded yearly together with the principal, would amount to $42,600.

During the past season we had occasion to make several Smith taps in the city mains and found the thickness as follows:

12-in. pipe	34 years old	.55 of an inch thick corresponding to about half way between class "B" and "C."
8-in. pipe	5 years old	[illegible] equals class "B."
6-in. pipe	With age from 33 years down to 4 years	With thickness of [illegible] equals class "D," [illegible] equals class "C," [illegible] equals class "B," .42 and .37 equals lighter than class "A."

A foundry test of 300 lb. to the square inch with vigorous hammer blows was required for the added pipe. All has been in service under identical working pressures as mentioned above.

Engineering Council's Committee Recommends Less Secrecy.—"Instability of labor employment resulting from strikes and lockouts has not been as serious in the metal trades industry as in some other industries, with the exception of the shipbuilding branch of this industry.

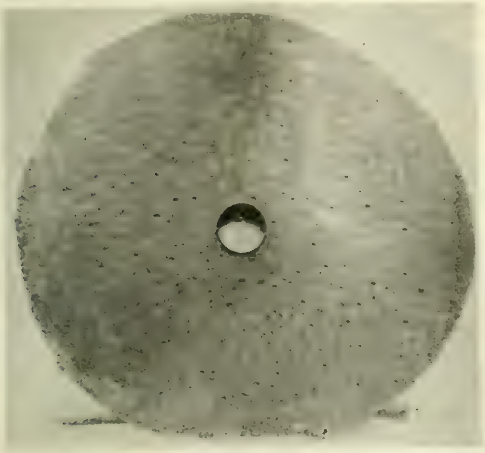
"An open interchange of ideas and business results by managements both in the particular industry and in other industries, should lead to a higher level of methods, service and general business ethics. If carried on through definite channels such interchange might easily result in a combined study of the possibilities of the future and the avoidance in the years to come, of such conditions as we are now facing. It is evident that management of labor must be elevated to a higher plane."—From the Report of the Committee on Elimination of Waste in Industry.

Condition of Steel Main After 22 Years of Service

Pits from 1-64 to 1-8-Inch Deep Mark 48-Inch Pipe Examined at New Bedford, Mass., Remaining Life Estimated at from 10 to 15 Years

The following account and illustration are taken from the report of the New Bedford Water Board for the year 1921.

No repairs of importance have been needed on the 48 in. steel force main. In connection with laying of the new 48 in. cast iron main, a 36 in. opening was cut out of the 48 in. steel main at Beaver Dam, for the purpose of connecting the new and old mains at this point. An examination of the piece which was cut out of the steel main, indicates that the main is in as good condition as might be expected after twenty-two years of service. The outside of the pipe is in perfect condition, but about one-half of the area of the inside is more or less pitted. Some of these pittings are small in area and quite deep (the deepest being about ⅛ in., or approximately 40 per cent of the original thickness) while others are of larger area and very little depth. A photograph of the interior of the piece which was cut out is herewith shown. The piece of steel has been cleaned with a wire brush with the exception of the small rough part of segment in the upper part of the picture.



36-Inch Section Cut in 1921 from 48-Inch Pipe Laid in 1898.

Mr. Conrad's report of the condition of the steel main, as indicated by the piece which was removed, is herewith presented.

An examination of the interior of the 48-in. steel force main immediately adjacent to the gate near where the Middleboro Road crosses the line, at what is known as Beaver Dam, disclosed that the interior is tuberculating considerable and that almost without exception wherever there is an accumulation of iron oxide there is a depression or pit in the wall of the pipe which varies in depth from 1/64 to ⅛ of an inch and there are some that would go beyond ⅛ of an inch in depth. In the pipe itself it would be unwise to disturb these tubercules, as unless the surface was thoroughly cleaned and a protective coating put on, the rate of growth of the pit would be accelerated.

At the place where the interior of the pipe was examined, a piece of pipe about 36 in. in diameter was cut out to provide for a cross connection with the 48-in. cast iron line, which is being constructed to connect with the 36-in. pipe at city line and Acushnet avenue. A calibration of this piece of pipe would indicate that the thickness of metal runs fully as heavy as was called for, namely—5/16 of an inch. It was not attempted to count the number of pittings in this piece of plate, but there are at least 200 and probably 250 or more places of areas from ¼ to 30 square inches in area scattered over the interior surface, which vary in depth from 1/16 to ⅛ in., which means a reduction in the thickness of the plate at these points of from 20 to 40 per cent. It is probable that the major portion of this pitting occurred during the earlier years of the pipe in service, and that their growth has slowed up somewhat, but it can readily be grasped that the years longer that the pipe line will continue to give the remarkable service that it has given during the past 22 years are probably numbered, and that probably within the next 12 to 15 years at longest it is likely to begin to give trouble.

An examination of the exterior of the pipe would indicate little if any deterioration of the plate on the outside, which means that the soil conditions over the pipe line right of way have been most favorable, and that the necessity for frequent examination on the outside to detect trouble is not going to be so necessary as a frequent examination inside from now on.

Discharge Capacity of Wood Pipe and Formulas for Calculating Flow*

By J. W. LEDOUX,

Consulting Engineer, Philadelphia, Pa.

Much has been written concerning the formula for flow in wood pipe. The writer is of the opinion that the formulas such as Hazen and Williams, Chezy and others, for new cast iron pipe are applicable to wood pipe of any age. It is quite probable that the flow through a perfectly new straight cast iron pipe would be slightly greater than for wood pipe of some age, due to the fact that the interior surface of the wood is more liable to have attached to it a film, or scum, which slightly reduces the flow.

The difference, however, is not very material, but for many situations the reduction in flow in cast iron, even in a very few years, makes the discharging capacity of the wood pipe much superior. For soft mountain waters and those of the Coast, where the color is high, cast iron pipe is likely to reduce within ten years, more than 20 per cent of its original capacity, due to tuberculation. Wood pipe is entirely free of this difficulty.

The writer made very careful and repeated tests of the flow through 10 miles of 24-in. wood pipe where the velocity was about 4 ft. per second, and found the coefficient in Chezy's formula to be 111. In this case the pipe was not perfectly round. If it had been round the flow would have increased. This phase of wood pipe operation is very important. Where the pipe is in a trench with a considerable fill over it and the pressure low, the pipe will assume an oblate form, the vertical diameter being materially less than the horizontal. The effect is to reduce the hydraulic mean radius and consequently the flow. When the pressure is increased materially, the pipe will become more nearly circular in form, and the coefficient will correspondingly increase. This is one reason why a great deal of trouble is experienced with leakage in wooden pipes. If it is subject to low pressure when installed and then after some years the pressure is increased materially, leakage is apt to develop along the staves as well as in the joints. The remedy is to constantly operate this class of pipe under fairly uniform pressures.

Calculation of Flow for Wood Pipes.—There are many wood pipes in service for flumes of short lengths, and an engineer is often at a loss to know how to calculate the flow in a very short pipe. The main point is to take account of the various losses of head that occur. The following formulae will apply to any pipe, be it short or long:

$$(1)\qquad Q = \frac{.3927\,D^{5/2}\,H^{1/2}}{\sqrt{\frac{L}{c^2} + .00582D}}$$

in which Q = cu. ft. per second.
D = diameter in feet.
H = total head in feet.
L = length in feet.
c = Chezy's coefficient.

Where the flow is in gallons per 24 hours, and the diameter of the pipe is in inches, the formula becomes:

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*From a paper presented at the recent annual convention of the American Water Works Association.

(2) q = [illegible]

in which q = gallons per 24 hours.
d = diameter of the pipe in inches.

These formulae allow for velocity head and entrance head equal to half the velocity head.

It will be noted that (1) is a modification of Chezy's formula and if this be reduced to velocity and the head taken as feet per thousand, and the pipe is indefinitely long, the formula reduces to:

$$(3)\qquad V = \frac{C\sqrt{Dh}}{63.2}$$

in which D = diameter in feet
h = head in feet per thousand.

Nearly all the investigators of the flow through pipe have concluded that the Chezy formula cannot be used with accuracy unless the value of C is changed to correspond to different diameters of pipe.

Scobey, Hazen & Williams, Moritz and others have made a very careful study of the flow of water in pipes, and Scobey's results and Hazen & Williams' correspond very closely. Taking Scobey's results on the basis of a loss due to friction of 1 ft. per thousand, we have

[illegible]

and the formulae of Hazen & Williams would give practically the same results, although slightly smaller, but it is much more convenient to use the Chezy formula even if we give to C different values corresponding to the diameters of the pipes, because the formula can be reduced to such a form as will allow for velocity and entrance heads, which is not practicable with the other formulae.

It is generally supposed that all the losses of head except that of friction vary with the square of the velocity. The importance of having a formula that is applicable for any length of pipe is shown by the fact that where only friction is taken into account, we would have a velocity in a 12-ft pipe of 6.05 ft. per second, while if the pipe were 1,000 ft. long the true velocity would be only 4.4 ft. per second.

Water Hammer in Wood Pipes*

By J. W. LEDOUX,

Consulting Engineer, Philadelphia, Pa.

It must be understood that wood pipe is as much subject to water hammer as is any other, so in selecting the pressure due consideration must be given to the possibility of material increase due to water hammer. There are many causes for water hammer. When the water in a long pipe is flowing at a high velocity, if a gate is shut down quickly, the velocity is reduced, and the inertia of the moving column of water causes increased pressure. If the line is flowing by gravity, and a heavy draft takes place in a low portion of the line, the discharge may be greater than the upper flatter portion of the pipe line is able to supply, in which case the column of water is likely to part, leaving a partial vacuum in a portion of the pipe line. This causes an acceleration of the moving column, so that if the draft is suddenly reduced the two columns will come together at an indefinitely high velocity, causing serious water hammer. The practical remedy for this situation is to use surge tanks or their equivalent.

The fundamental formula for water hammer is:

$$(6)\qquad p = \frac{.027\,LV}{T}$$

in which L = length of the pipe in feet
V = velocity
T = the time of extinguishing said velocity
p = pressure per square inch in excess of the hydrostatic pressure.

The pressure will reach a certain limit which depends on the length of pipe, the diameter, thickness and the quality of material.

Formula for Water Hammer for Wood Pipe.—To deduce a rational formula for water hammer for wood pipe to apply to a case when the velocity of water is stopped suddenly is a complicated process and at best uncertain. This branch of hydraulics, even for the simplest case, is more or less involved, and where we have the combined effect of the elasticity of the wood, of the steel bands and of the water, the complication is immeasurably increased. However, strict accuracy is not essential in any case, because the causes and effects of water hammer are subject to wide variation. The simplest formula is:

$$(7)\qquad p = V\left(\frac{3970\,Et}{Et + 294{,}000\,D}\right)^{1/2}$$

in which E = the coefficient of elasticity of the band
t = thickness of the material of the shell, i. e., the band
D = diameter of the pipe in inches
V = velocity in feet per second suddenly stopped.
p = pressure in pounds per square inch due to water hammer for instantaneous extinguishment of velocity
294,000 = coefficient of elasticity of water

For steel bands having a coefficient of elasticity of 28,000,000 this formula reduces to

$$(8)\qquad p = V\left(\frac{378000\,t}{95\,t + D}\right)^{1/2}$$

As an example, assume the pipe to be 24 in., 10,000 ft. long, thickness of band ⅛ in., velocity 5 ft. per second. If the velocity is suddenly stopped, p would equal 181 lbs. per square inch. By applying the fundamental formula it is seen that if the velocity is stopped in 7.4 seconds, or less, the result would be the same as if it were stopped instantly.

Incidentally it will be noted that the effect of sudden stopping is independent of the length of the pipe, and as the water hammer can never be greater than that due to sudden closing, we have a certain amount of insurance against the effect of closing valves too quickly. However, this insurance is more imaginary than real, because in both formulas the pressure due to water hammer is proportional to the velocity reduced, and there are many conditions which will produce accelerating and unduly high velocities, as for instance, a high rate of draft at a low portion of a pipe line; the sudden release of an accumulation of air, or anything that will produce a temporary vacuum in a portion of the line. Any one of these conditions will cause an acceleration, and water will run down the incline according to the law of falling bodies, and develop an indefinitely high velocity, which is suddenly extinguished when it meets the still column of water ahead.

Methods of Preventing Water Hammer.—The practical aspect of this matter is that everything possible should be done to prevent water hammer. The most effective remedies are in gravity lines to divide the total length into short sections by leveling reservoirs or surge tanks, and to provide a good design of automatic air valve on all the summits. For pumping where the line is long, water should be pumped into an elevated reservoir or standpipe close to the pumping station, and if this is impracticable, large air chambers should be used, and means for charging them with air. Where the pumps are centrifugal and run by electricity, the power occasionally goes off suddenly. The column of water, however, continues on some distance, causing a reduction of pressure at the pumps often below the atmosphere. The water column will then recede by gravity until it reaches the check valve at a high velocity, and as for this situation, air chambers are not usually provided, a serious water hammer takes place, which is the cause of a great many broken discharge mains. A simple remedy is to connect the discharge main outside of the check with a tank kept full of water and between the tank and the discharge main should be a check valve opening outwardly. The main will then be kept full of water, and as soon as the velocity is reduced to zero the column of water will not recede and no water hammer will take place.

New England Waterworks Association Outing.—A visit to Scituate Dam and other points of interest will be made by members of the Association and their friends on June 27. Party assembles at 11:00 a. m. outside the west portico of Providence Union Station. Returning, arrive Union Station 5:30 p. m.

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*[illegible]

Concrete Pipe with Improved Joints as Used in St. John, New Brunswick

Features Developed in the United States Adopted by Canadian City

A 36 in. reinforced concrete supply line, about 4 miles long, was recently laid by the city of St. John to supplement its existing water supply. The following account of the pipe, giving special attention to the joints is taken from the Contract Record, Toronto.

This pipe, the design of which is patented, has a 4 in. wall and is made of concrete, reinforced with steel bars and triangular wire mesh. It is built in 12 ft. lengths, into one end of which is moulded a cast iron machined bell ring and into the other end a cast iron machined spigot ring. The process of manufacture involves the securing of these two rings, along with the longitudinal and circumferential reinforcing steel into a firm cage pipe, which cage can be handled as a unit and the elements of which are securely fixed in the proper positions with the result that each linear foot of pipe as manufactured has arranged within it exactly the quantity of reinforcement designed and at the exact spacing desired. Six longitudinal bars of ⅝ in. round steel serve as the framework of the cage, and at the same time by means of hooked ends they secure at proper distances the cast iron bell and spigot rings. To these longitudinal bars are secured the circumferential mesh or bars, as the case may be. When circumferential bars are used they are each tied firmly to each of the longitudinals by means of crimped steel ribbon 1/16 in. by ⅜ in.; the crimps in each ribbon are at the proper centering for fixing the bar hoops. The pipe in question is for use under hydrostatic heads of from 20 ft. to 78 ft., corresponding with the elevation of the trench bottom along the profile of the line.

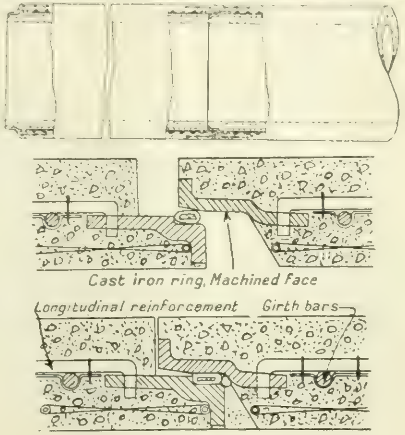
The steel in this pipe is designed for operations under static head at a stress of 12,000 lb. per square inch. The bar in each hoop is lapped on itself thirty diameters, and these laps in conservative hoops in the cage are spiralled around the periphery.

The concrete used in the manufacture of this pipe was all screened sea-beach gravel and sand, the maximum size gravel being about ⅝ in. in diameter, all over size being crushed. This class of material, which was the only material available for the purpose, was quite harsh, although fairly graded, and to overcome this defect, which would otherwise have caused segregation during the pouring of the concrete and leakage through the wall of the pipe thereafter, addition of about 2 per cent of clay was made, the result being a very "fat" mixture and one which flowed easily into the narrow forms and thoroughly about the reinforcing steel with a minimum of separation of the stony aggregate and a minimum loss of the water of the concrete. This class of concrete is necessarily poured quite wet through not so wet that the gravel or coarser particles will sink or fail to float in the fluid mass. In order to insure a water-tight body round about the bell and the spigot rings those portions of the pipe were moulded with mortar rather than with concrete. The pipes were cast on end within steel forms and the deposited concrete was thoroughly sliced and worked, special care being given to the complete and thorough filling and working of the upper or spigot end of the pipe wall.

The forms within which this pipe is moulded consist of cylinders of 3/16 in. plate, carefully assembled to accurate dimension. When in upright position the inner and outer forms rest upon finished cast iron base rings, being held in respective proper positions by means of circumferential beadings upon these bases. For the manufacture of twelve pipes per day or 144 ft. of pipe, thirty-six of such bases were in constant use along with twelve inner and outer forms and twelve spigot moulds. In order to release these forms each day the temperature of the fluid concrete is kept in the neighborhood of 100 deg. by means of heavy duck coverings. The inner and outer forms are so designed as to be capable the one of contraction and the other of expansion so that each may be lifted clear of the comparatively green concrete pipe without injury thereto. The surface of the forms is kept absolutely clean and true and is oiled before being used. This practice of oiling metal surfaces is applied throughout the entire job to all vehicles or containers of the wet concrete, such as the mixers and concrete distributing bucket and the concrete chute or hopper which receives the product of the mixers. This precaution is valuable as preventing the accumulation and accidental inclusion of dead concrete within fresh concrete.

The joint which is used for this line of water supply is one which was devised during 1917. It has, it is said, been thoroughly tested in the shape of models and of full-sized test sections from 15 in. to 48 in. in diameter, and has been applied to water service for Kansas City, for Cumberland, Md., in Massachusetts, and during 1921 was also built into 5 miles of line for Norfolk, Va., which latter proposition was also of 36 in. pipe.

As stated above, this pipe carries a machined cast iron bell and a machined cast iron spigot—see the illustration. Within the bell casting is cut a wedge-shaped groove of about ¾ in. width; the surface of the spigot ring is finished conically for part of its length and cylindrically for the remainder or working portion of the length of the spigot ring. The joint between spigot and bell of consecutive pipes is made water-tight by means of an elastic lead pipe gasket. This gasket consists of a relatively light weight lead pipe of diameter not exceeding ½ in. standard, within which pipe is drawn a good filling of cotton wicking. The lead pipe, so filled with cotton, is cut to proper length, rolled to an elliptical section and then soldered into a complete hoop. This hoop is of diameter to fit into the wedge-shaped groove in the bell casting, and the gasket is then caulked by forcing the adjacent pipe into place, the taper end of the spigot wedging the gasket radially into its seat so that it ultimately rides upon the cylindrical surface of the spigot. The assembly of such a joint requires considerable longitudinal force, which is applied by means of long bolts. The work in the trench is limited to this assembly and can, it is said, be carried out in all weathers and under all trench conditions, even when the trench floor is submerged. This type of joint has, we understand, proved water-tight under high pressure and even by the use of steam pressure up to a temperature approaching the melting point of lead. The joint when assembled is flexible and will conform to irregularities in the settlement of trench foundation. It is a true expansion joint, its water-tightness not being affected by changes in the temperature of the flowing water which will cause changes in the gross length of the pipe line. A continuous cylindrical inside surface is provided in a pipe so designed with a resultant large capacity.



Details of Joint in St. John Concrete Main.

The work was carried out by the council of the city of St. John, operating through its commissioner of water and sewerage, Mr. J. B. Jones, and its city engineer, Mr. G. G. Hare. The contractor was Canada Lock Joint Pipe, Limited.

Both houses of Congress have passed bills permitting the execution of plans for port improvements as worked out by the Port of New York Authority. Legislatures of both States have already approved these plans, and it now appears probable that the work will be undertaken.

Water Softening as a Factor in Municipal Supply*

By WM. M. BARR

[illegible] Chemist, Union Pacific [illegible], Omaha, Nebraska

It is almost an axiom that a good water supply is essential to the prosperity of a municipality. Great improvement has been made in recent years in the quality of water supplied even in the smaller towns and villages of the country. This improvement has been largely the result of the growing understanding of the direct benefit to be derived in the health of the people by the use of good water. It is natural then that the first great improvement has been along sanitary lines. There is no longer any excuse for epidemics of typhoid resulting from contaminated water supply, since modern methods of sterilization assure us a safe water at a nominal expense.

Frequently, however, an adequate volume of water cannot be had except from streams which may not only be polluted by organisms but usually carry a considerable quantity of suspended matter, which makes the water distasteful in appearance as well as unpalatable. This condition has also been improved by filtration, which in combination with sterilization has been brought to such a degree of efficiency that it is within reach of even the smaller communities. As civilization advances our demands are more exacting and all of our requirements reach a higher and higher plane as the possibilities for satisfying requirements are made easier.

While public officials have given considerable attention to sanitation and to public health, by delivering to the people a safe water and one of good appearance, it is rare to find city officials considering the comfort of the housewife, the convenience of the manufacturer or the economics of his factory when making provisions for municipal water supply.

The Soft Water of Portland.—Some of our cities have been especially blessed by nature by having a pure, clear, cold soft water delivered almost at their doors under ample pressure, with nothing left to be done but to install the distributing system. Such a city is Portland, Ore., where the melting snows of Mount Hood collect in a natural reservoir and discharge into a stream at an elevation far above the city. This stream is well protected and the pipe line collects the water at such an elevation as to give satisfactory distribution. This water is as near to absolute purity as nature can supply.

Analysis shows less than 1.5 grains of dissolved mineral solids per gallon, with practically no organic matter. This is an ideal water for all purposes and is one of the cheapest supplies in the country. The absence of hardness in this water makes the soap consumption of this city one of the lowest in the country.

The Supplies of Los Angeles and Omaha.—Other cities have had to bring their water hundreds of miles at great expense to provide even a safe water supply of ample proportions. Los Angeles brings its water from a source 265 miles distant at enormous cost, but it has a good sanitary supply. This water contains 1.65 lb. of soap destroying material per 1,000 gal. of water. This will consume 1.1 lb. of good laundry soap costing 10c or more. If used for household purposes this must be added to the cost of the water.

Omaha city water contains about 3 lbs. of soap destroying material per 1,000 gal. of water, although it varies considerably with the season and at times contains more than this. For a little more than 1c per 1,000 gal. most of the carbonate hardness could be removed and the soap consumption be reduced thereby at least [illegible] per cent.

The same is true of most of the cities using Missouri River water. As coagulation is required on this water, demanding large settling basins, it is only necessary to add the proper equipment for feeding lime.

It has been estimated that it would cost the City of Omaha [illegible] per day to treat the water as suggested. If 10 per cent of the total supply is used with soap there would be a saving of [illegible] per day in the cost of soap, to say nothing of the comfort and convenience derived from soft water.

[illegible] waters from [illegible] streams are looked upon as being [illegible] hard, there are some towns [illegible] favorably located where underground waters are used. While the water is perfectly clear and sanitary it carries so much material in solution that the stranger wonders what the people in that locality do when they want a bath.

The Manufacturer Prefers Soft Water.—If a manufacturer is considering the possibility of a new location, the city having a pure soft water will be given preference over the one having a hard water, assuming that other conditions are equal. It is, therefore, to the advantage of a community as a whole to offer a satisfactory industrial water supply to those who are seeking locations for new industries. But the manufacturer is not the only one to be considered, nor should it be so. If you consider the greatest good to the greatest number, we should reach all classes of citizens and there are few in any community who do not use soap. If there be such I will venture to say he would not object to taxation on that ground.

The comfort and economy of the housewife affects the whole people, and there is no improvement that would meet with more favor in the community than the production of a soft water from one that has been disagreeably hard.

Water Softening at St. Louis.—Many people will say that softening a municipal supply is too expensive. The city of St. Louis has not found it so, and they produce more than a hundred million gallons of soft water per day. It is a noteworthy fact that people going to that city from many other Middle Western points comment favorably upon the soft character of that city's water supply. The total hardness is reduced approximately 60 per cent. I do not mean that it would be feasible to remove all of the scale forming salts from the city supply, but the removal of the carbonate hardness makes a vast difference in the washing qualities of water, and adds much to the comfort of the people, and while the people may pay a premium on such a water they are simply transferring the charge to the water account from the soap account. It is certainly cheaper to remove the carbonate hardness with lime than with soap. Most of the cities that treat their water supply in this way do not attempt to remove all of the carbonate hardness as some consider it more palatable if all of the hardness is not removed. If the water is well aerated, this objection does not hold.

In addition to this there are other advantages to be gained in the water purification process itself by the use of lime, which is added primarily for the purpose of softening the water. We have in our own city a water system in which filtration does not play a part, and as a result there are times when this water is not perfectly clear. It is possible by using a sufficient amount of lime to remove a large portion of the carbonate hardness, to obtain a clear water even with a reduction of the amount of alum used for coagulation.

The up-to-date industrial plant in this city has provided itself with a complete water softening equipment purely as a matter of economy without any coagulant other than the precipitates formed by the reaction between the lime and soda ash with the scale forming salts contained in the water. This applies to plants using raw Missouri River water as well as those using the clarified city water. Nor does this exempt the municipal industries themselves who have found it to their advantage to install such treatment. From this treatment a surprisingly clear water is obtained which gives little trouble in boilers from the formation of scale and which yields a substantial return on the investment in the efficiency of operation and economy in maintenance of the power plant.

I do not mean to advocate here that filters should not be used; I believe that any city is entitled to the best water that can be produced and therefore believe in filtration following coagulation and softening with ample settling basins to clarify it. Such treatment greatly reduces the amount of filtering area required and therefore the initial cost of filters, as well as the operating cost.

There are many people who consider softening of a municipal supply an unnecessary refinement but I submit to you that if a water can be furnished with more than 50 per cent of the hardness removed, at a cost of from one to two cents per 1,000 gal., that such an operation would pay and be greatly appreciated by a large number of citizens. This method is particularly applicable to city plants where turbid waters are taken from the streams and clarified by coagulation and settling. The necessary softening equipment can be installed on such a plant at a nominal cost. I know of no improvement involving so small an expenditure that would meet with such universal approval in the community.

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*[illegible] before the [illegible] Section of the American [illegible] Association.

Water Purification Plant Operation in Illinois

Data on Plants Given in Paper Presented March 29, at Annual Meeting of Illinois Section of American Waterworks Association

By M. W. COWLES,

Assistant Engineer and Analyst, Illinois State Department of Public Health

The first purification plant in Illinois was built in 1885 in East St. Louis, followed by Streator in 1889 and Quincy in 1891. Since that time the original plants have been largely replaced. At the present time there are in Illinois 39 supplies subjected to fairly complete purification; 2 supplies that are softened; 2 supplies where iron is removed; 14 supplies which are more or less continually sterilized by the use of liquid chlorine or hypochlorite without coagulation or filtration, and 4 supplies where sterilization is used only under emergency conditions.

The population supplied by the 39 water-purification plants, on the basis of figures given by the 1920 census, amounted to 589,385; by the 18 sterilization plants, 3,074,000 (including Chicago), and by the iron-removal and softening plants, 53,515, making a total population of 3,697,231, which is supplied by artificially treated water.

The various processes by which water is purified, excluding softening and iron removal, can be considered to take place in four different stages (1) preliminary treatment, including pre-sedimentation, aeration, etc.; (2) coagulation followed by sedimentation; (3) filtration; and (4) sterilization. For convenience, the first two groups will be discussed together as treatment preliminary to filtration.

Treatment Preliminary to Filtration.—Of the water-purification plants in Illinois only that at East St. Louis is provided with pre-sedimentation basins, used prior to the addition of coagulative chemicals.

Aeration facilities for the raw water before it enters the mixing chambers or coagulating basins, are available at Danville, Jacksonville and Murphysboro for use whenever growths of taste and odor-producing organisms occur in the reservoir water. At Danville, a splash aerator, consisting of vertical pipes discharging onto circular perforated shields or "umbrellas" is used. The arrangement at Murphysboro is somewhat similar but consists of a vertical pipe discharging into the air about 3 or 4 ft. above the level of the water in the chamber into which it falls. At Jacksonville, spray nozzles operated by gravity flow from the reservoir are used.

The total sedimentation and coagulation period used varies for water from storage or impounding reservoirs from 2.1 hours at Pontiac to 9.6 hours at Streator and for water from streams from 2.2 hours at Moline to 18.0 hours at Rock Island.

At East St. Louis, assuming a normal daily raw-water pumpage of 20 million gallons, the pre-sedimentation period alone amounts to about 5¾ hours and the coagulation period about 9½ hours. This period is probably sufficient during times of low turbidity and relatively low bacterial content, but during times of high turbidity, or at times when the water is rather highly polluted, this period is insufficient and causes overloading of the filters and a poor quality of filtered water, prior to chlorination.

At Rock Island and Streator, the basins are arranged so that sedimentation prior to coagulation could readily be permitted and more economical and possibly somewhat better operation of the plant as a whole could be obtained in this manner. At other plants supplied either from streams or from small reservoirs where the variation in suspended material is considerable, better results could also be obtained if a pre-sedimentation period were provided prior to and in addition to the sedimentation after coagulation.

In some of the smaller plants, the capacity of each part of the purification plant greatly exceeds the demand of domestic consumption and the plant, therefore, operates only a few hours each day. Where the coagulent is added without pre-sedimentation, as is usually the case, the alum floc will settle out and that reaching the filters will be insufficient to form a proper mat on the top of the sand. Provision for a second dose of alum might be of value. Such a condition is unsatisfactory and it is believed that more attention should be paid to this feature of design, in providing a more flexible plant, which can more readily meet the requirements.

The plants at Rock Island and Streator are arranged so that with a few minor changes, the point of addition of the coagulant can be changed in accordance with the quality of the raw water, thereby giving the plant more flexibility to enable it to meet adverse conditions.

Coagulating Chemicals Used at the Various Plants.—With the exception of Alton and Herrin (temporarily), all use alum and a number also lime or soda ash when required. Recent analyses of some of the raw waters from plants which now do not use lime or soda ash have shown that the natural alakalinity of the water as measured by methyl orange, may fall below 40, indicating the necessity of the addition of some alkaline material, especially during the winter months when the lower temperature of the water tends to slow down the rate of chemical reaction.

Inspections which have been made of 23 of the purification plants within the past 18 months have shown that the facilities for adding coagulants are, in many plants, quite crude and cannot be depended upon to provide an even dose or one which can be proportioned in accordance with the raw-water flow at any particular time. Hand operation of a gate valve is often depended upon to secure variation in coagulant.

Of the plants inspected, Decatur, East St. Louis, Quincy, Hamilton, Herrin, Marion, Rock Island, Salem, Sparta, Streator and Dallas City have devices which are capable of satisfactory control. A few of the plants, especially the larger ones, have automatic devices for varying the amount of coagulant added in proportion to the raw water pumped.

At Rock Island, an attempt has been made to use a solution of 4.8 per cent strength which has resulted in corrosion not only in the solution-controlling devices but also to a greater extent in the pipe line leading a distance of 350 ft. to the point of application of the coagulant. Lead lined, galvanized and fiber pipe were unsatisfactory and lead is now being substituted. A 2 or 3 per cent solution would be less corrosive and probably would produce as satisfactory results.

When the addition of alkaline material is necessary to secure proper precipitation of the coagulant, the alkaline material and the coagulant are sometimes added to the water either through the same or separate pipes at the same point. It is believed that this method is undesirable for either lime or soda ash. In the case of lime, it may be somewhat more objectionable than in the case of soda ash, on account of the lower solubility of hydrated lime in cold water and the tendency for small particles of suspended lime which are not in solution to be carried along mechanically and, therefore, of little influence for the purpose for which it was added. In either case, better and more satisfactory results could be expected if the alkaline material is added and thoroughly mixed with the raw water a short time before the coagulant is added. If added, a considerable time before the coagulant is added, some softening action may occur, requiring the use of amounts of lime or soda ash greater than that required by the coagulant alone, but with better results. If it is not considered desirable to add the chemical in the suction of low-service pumps, a satisfactory mixture of the raw water with the alkaline material can well be obtained by passing the raw water through a Venturi section or reduced section in the raw-water conduit. Laboratory experiments by Dr. F. A. Hale at the Mount Prospect Laboratory in Brooklyn have indicated that very complete dispersion of chemical in the water to be treated can be obtained in this manner. Ellms has also proposed the "hydraulic pump" for securing a proper mixture.

Mixing Raw Water with Coagulant Solution.—A considerable number of the Illinois plants are designed without adequate facilities for securing a thorough and intimate mixture of the raw water with the coagulant solution. Of the 23 plants which have been recently inspected, 20 have some provision for mixing chambers, the length of time varying from to 2 minutes to a maximum of [illegible] minutes based on the average consumption. Danville, Jacksonville and Salem, recently completed plants, have periods of [illegible] 4 and 16 minutes, respectively. At Jacksonville the plant is carrying an overload of about [illegible] per cent, and mixing and coagulation basins and an additional filter will shortly be provided.

Recent experiments made at Sacramento, Cal., have shown that most satisfactory results in coagulation can be obtained by the use of a mixing chamber having a velocity of 2 ft. per second. Such a mixing chamber must be baffled in such a way that all velocity at all points is as nearly uniform as possible and at least it does not drop below the velocity at which sedimentation will occur. Mechanical stirring devices also produced good results and had a decided advantage over the closely baffled tank in that the capacity was more flexible. After the coagulant is added and the water has passed through the mixing chambers it is suggested by Mr. Langelier that more efficient coagulation can be obtained by gradually decreasing the velocity by gradully increasing the cross section of the coagulation basin, and further, that the velocity in this basin should vary between a higher limit of 0.15 ft. per second and a lower limit of 0.[illegible] ft. per second.

Many articles with reference to the chemical processes involved in coagulation have recently appeared in the literature. [illegible] in a recent paper delivered before the American Water Works Association at Cleveland emphasized the necessity of greater reaction periods for the chemical changes to occur, and urged that in water purification more attention be given to the factors which are known to affect the speed of a chemical reaction, temperature, contact of reacting substances, etc.

Proportioning the amount of coagulant to the turbidity of the raw water is not given proper attention. The arrangement used at Decatur (similar devices may be used at other points in the State) has much to recommend it. The approximate amount required for different turbidities, as determined from plant records, has been plotted.* Minor variations are made by observing the size of the floc as it passes to the filters by means of an electric light bulb hanging just above the surface of the water.

"Rule of thumb" methods are still necessary, but that does not preclude the use of all available tests to secure additional information. It is hoped that before long, colloidal chemistry may give us a better measuring stick.

It is also interesting to note that at one plant, at Breese, coagulation and sedimentation for a period of about 35 hours constitutes the entire treatment given a surface supply from Shoal Creek. The treatment is inadequate and filters should be installed. Lime and iron was used at one time, but this has apparently been replaced by lime and alum.

Filtration Plants in Illinois. The filtration plants in Illinois, numbering 43, including the two softening and two iron-removal plants, comprise 6 pressure-filter installations, operated as pressure filters and 37 rapid sand filters of the gravity type. The last slow sand filter in Illinois, at Great Lakes Naval Training Station, was replaced about 1917 by a rapid sand filter.

In the 36 plants for which data are available, there are 174 filter units, including 116 concrete filters, 12 vertical steel tubs, 18 vertical wooden tubs, 6 vertical steel tanks, and 22 horizontal steel drums, both tanks and drums having once been used as pressure filters. In the 6 pressure-filter installations there are 20 pressure-filter units, 9 horizontal steel drums and 11 vertical steel tanks. Nearly all of the rapid sand filters are designed for a rate of 2 gal. per square foot per minute or 125 million gallons per acre per day.

New filter installations or enlargements to existing plants, subject to the approval of the State Health Department, are usually of the gravity type. The department considers that pressure filters are unsatisfactory for public water supplies because the operator cannot observe the condition of the sand in the filters, and the effect of washing because the interiors of the filters are not very accessible for cleaning and repairs and because of the high wash water rates. When operated as pressure filters, as at East St. Louis and Streator, they have the advantage of having a capacity of considerable overload, which from a sanitary standpoint may not be desirable. At East St. Louis these horizontal drum filters handle about 11 million gallons daily or about 45 per cent of the supply. With both types of filters, it is possible by comparison of the two effluents and the condition of the settled water, for the operator to know somewhat more about the condition of the pressure filters than would be possible if pressure-type filters alone were available.

Filter Control. In order to secure proper and adequate filtration, the operator must be provided with some means of securing information concerning the condition of the filter units by loss-of-head gages or rate controllers. It is believed that one point in this connection is sometimes neglected in discussions of filter control, namely, the memory of the operator. In a small plant, with a few filters, some degree of control can be obtained through reliance on knowledge of operating conditions obtained through memory alone, but in a larger plant this is manifestly impracticable. Such a statement does not mean that both of these devices, rate controllers and loss-of-head gages, are not very desirable in a small plant. A good operator of a small plant can secure satisfactory results with only one of these devices, but much better operating results can be obtained if the filters are provided with both devices. In larger plants, both devices are essential.

At many of the plants, the operators have never familiarized themselves with the construction of the rate controllers or the loss-of-head gages, and consequently they are unable to repair either of the devices if a part is accidentally broken, or to reset them, in case they do not record accurately or operate properly. The setting of a rate controller is usually a relatively simple matter, the rate of vertical drop in a filter being 3.2 inches when water is passing through the controller at the nominal rate, 2 gal. per square foot per minute. During the inspections by engineers of the department it is endeavored to advise and assist the operators in overhauling the controlling devices and again placing them in service and to indicate to them as forcefully as possible the necessity of maintaining them in accurate and continuous service.

Most Efficient Size of Sand.—In recent literature have appeared several articles relative to the most efficient size of sand for rapid sand filter plants. Dittoe and Catlett agree that the effective size should vary between 0.35 and 0.40 mms. with a uniformity conformity coefficient from 1.5 to 1.8. The Ohio requirements as outlined by Mr. Dittoe give a preference to sand of 0.37 mms. effective size with a uniformity coefficient not exceeding 1.6, all particles to be finer than 1 mm.

Laboratory examinations of samples of sand collected during the past 18 months from 18 rapid sand filter plants, show that the effective size of sands now actually in use range from 0.32 mms. at Decatur and Mt. Carmel to 1.45 mms. at Alton. The average effective size is .51 mms. and uniformity coefficient of 1.52. The effective size of 75 per cent of the sands will range between 0.32 and 0.50 mms.

At Alton where lime and iron is used, the sand in the east filter has an effective size 0.87 mms. and the west filter a size of 1.45 mms., whereas the Redwing sand as originally installed in the east filter in 1915 had an effective size of 0.30 mm. and uniformity coefficient of 1.5.

The growth has been largely due to accretions of calcium carbonate. At Anna State Hospital, the sand was black and was coated with a considerable deposit of lime with a large proportion of iron and manganese. The sand as obtained from the filters had an effective size of 0.55 mms. and a uniformity coefficient of 1.13, while the effective size and uniformity coefficient of the washed sand was 0.50 mm. and 1.20, respectively. A portion of this water supply contains manganese, and the coating on the filter sand apparently may produce a reduction of manganese and possibly also of iron by means of an absorptive effect.

In a discussion of Mr. Dittoe's paper, Mr. Alexander Potter, a consulting engineer of New York City, states that this requirement of sand size caused considerable additional expense at Warren, O., as well as delay in placing the plant in operation. He further points out that if at one plant in Ohio the sand size has increased from 0.39 to 0.44 without sacrifice in bacterial efficiency, the specifications may be too narrow. The author feels that this objection may be well taken considering the growth of sand in filters and that more emphasis should perhaps be placed on the absence of very course or very fine material affecting both features of the size rating and more attention given to proper grading of the underlying gravel rather than to place too great emphasis on exact conformity to fixed specifications for the sand.

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*[illegible]

Air and Water Work.—Of the 43 plants, 15 apparently have facilities for air and water wash, air being used for about 3 to 5 minutes followed by water for a period sufficient to lower the turbidity of the waste water. The wash-water rates expressed in inches vertical rise per minute, range from 4.8 in. vertical rise per minute at Charleston to 18 in. at Jacksonville and Mt. Vernon and 22 in. in the newer filters at Alton. At a recent plant at Dallas City, installed without first submitting plans to this department, as air agitation of 20 minutes is used followed by a 4-minute water wash. For the most part, these systems with both air and water wash were installed at a time when it was believed that a wash water rate of 4.8 in. vertical rise per minute was sufficient. Air agitation can be used if applied intelligently, but a careless or inexperienced operator can easily disturb the filtering qualities of a sand bed.

Experiments made by Ellms and Gettrust at Cincinnati in 1916 showed that a much higher velocity (20-24 in.) could be used providing the wash water was applied below a gravel bed of proper size and thickness upon which the sand was placed. A rate of 15-20 in. is possible, without specially constructed filter bottoms, by the ordinary strainers if the gravel be properly graded in 4 or 5 different sizes with a total depth of at least 18 in. The wash-water troughs must be sufficiently high above the top of the sand beds so that sand will not be wasted. If higher, the grit and other material will not be washed away; if lower, sand will be lost. Some idea of the expansion of a sand of any perticular size at a particular wash-water rate can be obtained from tables in the "Waterworks Handbook." The same rate of wash with a coarser sand will not raise it as high, vice versa.

The higher velocity of wash water effectively stirs up the entire sand bed and thereby removes much of the tendency for mud balls to form and affords more complete and thorough washing of the sand bed. Where the wash-water distribution or collecting system is not properly proportioned, these higher velocities sometimes cannot be used, in which case the filters should be overhauled and a new underdrain system provided. High velocity washing is not a cure-all, but the factor of rapid and thorough cleaning of the filter bed is of no mean importance.

It is believed that the unsatisfactory quality of the filtered water obtained from several of the purification plants may largely be due to improper washing, either inadequate or excessive. If mud balls should form or the distribution of wash water is imperfect, some portions of the filter may be over-washed, discharging a waste water of low turbidity, while other portions may receive an insufficient amount of washing. Should the filter be over-washed, settled water containing coagulant must be wasted until a proper mat is formed on the over-washed portions. The inefficiency of this method is evident. If the filters were washed uniformly but washing stopped while water was still somewhat turbid, the filter would be in better condition and less wash-water would be required.

Underdrain Systems.—Recent articles are again showing a trend toward simpler underdrain systems and have indicated that satisfactory underdrains can be made by the use of perforated pipe. An underdrain system of this character has been used at Harrisburg, Pa., for 15 years. One possible objection to such a method is the clogging or corrosion of these offices, which apparently does not constitute as serious a factor as the corrosion between different metals, as for instance where brass strainers are used with iron pipe. The Wheeler filter bottoms and other devices of concrete with glass orifices, are also in rather extensive use, with more or less success. In any case, careful design of the collecting system is essential in order that the quantity of water discharged from the various orifices might be as nearly equal as possible, affording equal rates of filtration or distribution of wash-water over the filter surface.

Sterilization.—Of the 38 filter plants in Illinois, for which data are available, 9 now use calcium hypochlorite and 29 liquid chlorine. At Elgin, the highly polluted river water after filtration is chlorinated twice before it is discharged into the distribution systems. Of the 17 places where sterilization is the only treatment, all but Waukegan use liquid chlorine.

At Eldorado, Kenilworth, Macomb, Mt. Vernon and Rock Island, and until recently at Alton, the sterilizing agent is added to the settled water prior to filtration. At Rock Island the filtered water, sterilized previous to filtration, is stored in open basins subject to more or less accidental or malicious contamination, and under these conditions it is expected that analyses would give more or less inconsistent results.

At many of the plants the sterilizing agent is added as the water enters the clear-water basin from the filters. At several plants the water in the clear water basin may become contaminated. The application of the sterilizing agent as the water enters the clear-water basin is not entirely satisfactory unless the plant is designed and properly balanced as regards capacities of filters and clear-water basin, and the consumption, and the clear-water basin is provided with suitable baffles to prevent short circuit of the sterilized water directly into the pump suction and to prevent the formation of "pockets" of water which has been sterilized several days previous. Such a condition can seldom obtain on account of the necessity of providing reserve clear-water capacity to meet fire and other emergencies.

The quality of the effluent would, therefore, vary so that it is often desirable to add the chlorine to the pump suction so that it will be properly and thoroughly mixed in the pump cylinders. The addition of the sterilizing agent into the pump suction may have a tendency to cause corrosion, but in a recent article, of some 15 persons in charge of water-purification plants, only about 6 stated that little corrosion would result considering the small quantities used. A centrifugal pump might be more subject to corrosion than would a piston-type pump. This does not, however, affect the desirability of providing the clear-water basin with suitable baffles so as to avoid conditions of stagnation or to minimize any possible contamination.

At East St. Louis, a short circuit frequently obtains in the smaller clear-water basin in which the sterilizing agent is applied to the water as it enters the basin, and it is possible that some of the water in the basin may remain stagnant for several days after the chlorine has been added. Similar conditions obtain at Moline and Pontiac. At Danville, difficulty from overgrowths in the distribution system could possibly be attributed to improper arrangement and operation of the clear-water basin.

This suggests that much of the problem of aftergrowth in the mains may be due to faulty arrangement or operation of the filters, clear-water basin and sterilizing equipment. These difficulties might be prevented by a careful study into the possible paths which water might take through the parts of the purification plant.

Difficulty in obtaining effective sterilization has been caused in some cases by improper installation of the chlorinating equipment and in others by improper operation and maintenance of the equipment. In one case, little regard was paid to the actual capacity of the pumping equipment, the pump being operated at a rate equal to twice the daily consumption, but only during a period of 12 hours. Failure to provide a supply of extra parts for chlorinators and to make the operators familiar with the construction of the chlorinator to enable them to keep the chlorinator in service even though some one part is out of commission, are two essential causes of intermittent action of the chlorinators. The operators are warned that the machines are delicate but, for the most part, they have not been carefully instructed in regard to the more frequent causes of breakdown, such as leaky valves, clogging of tubing, etc. Wherever trouble is found, the engineers of the State Department of Health instruct the operators in the solution of these difficulties.

It is very essential that proper records of the amount of chlorine added and the amount of water pumped be maintained, especially for surface supplies where the clhorine absorption value of the water varies materially with changing weather conditions. The amount of chlorine added should be checked not only by recording the flow of chlorine through the measuring devices, but also by weighing the drums on platform scales. These records, together with the results of daily or better, twice daily, control tests for excess chlorine by means of ortho-tolidin, will enable the operator to add sufficient sterilizing agent with but little danger of overdose and production of complaints of tastes and odors.

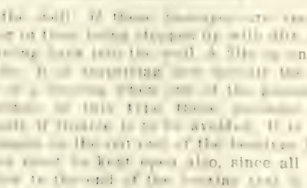
The results of tests for free chlorine obtained by the use of ortho-tolidin as indicated in "Standard Methods" are not considered always reliable, especially in waters which contain nitrites, ferric salts, chlorates and probably other oxidizing agents. Relatively little has been written describing in detail the reasons for ortho-tolidin giving erroneous values. It has been suggested by Wolman that frequent tests be made on the raw and sterilized waters and that by a comparison of the results, chlorine can be added so that an excess may always be present in the treated water. In this article a 5-minute absorption period has been suggested to govern the amount of excess chlorine remaining in the water, but at least for Illinois conditions it seems more logical to allow a longer absorption period varied in accordance with the distance of the first consumer from the sterilization plant. It is believed that this period may not in all cases satisfy the chlorine demands of the water.

Control of Sterilization by Tests for Excess Chlorine.—In August, 1921, the control of sterilization by tests for excess chlorine was adopted on the untreated water supply for New York City obtained from the Ashokan and the Kensico reservoirs. Bacterial control was still continued but it was hoped by the Public Health Service, which recommended this change, that better results could be obtained by this method of control. In November, the results so far obtained were reasonably satisfactory. For a surface supply of this character without an abnormally large increase in organic matter or of turbidity after heavy rains, and where the chemical constituents would remain fairly constant, it is thought that this method may give satisfactory results. The collection of bacterial samples from the distribution system when compared with the results of ortho-tolidin determinations are, however, necessary to determine whether or not the water is being properly treated.

In cases of a supply which is purified by filtration with or without chemical treatment, the raw water before chlorination may show a yellow color with ortho-tolidin and the ortho-tolidin tests cannot be considered reliable because filtration may, under certain conditions, remove the color-producing material. Where bacteriological control cannot be made available at once, ortho-tolidin tests on the filtered water prior to sterilization and on the same after sterilization can be made of considerable value. It is possible that a surface supply without purification other than sterilization, may be properly controlled by tests for free chlorine on the raw and sterilized water, providing a large excess of free chlorine is maintained or proper consideration given to a sufficiently long absorption period. A turbid surface supply such as is usually found in Illinois and other central-western States, can be properly sterilized if sufficient care is taken to add ample quantities of chlorine.

Leaky Bearings Caused by Stopped-up Oil Passage

Trouble is experienced quite frequently with oil leaking out of motor bearings, which if not remedied may result in badly worn or burned-out bearings. This trouble, writes B. A. Briggs in Power, is found chiefly in bearings that have a small passageway for the oil to return from the end of the bearing to the oil well. In the bearing shown in the illustration the oil is carried by the rings up onto the shaft and then back through the oilways and out between the shaft and bearing and is discharged at each end into the housing at A and A. From here it flows through the oil passages B and B into the well. If these passages are small there is always danger of them being stopped up with dirt and instead of the oil flowing back into the well it fills up and runs over to the outside. It is surprising how quickly the oil can be emptied out of a bearing when one of the passages is filled up. In bearings of this type these passages should be watched closely if trouble is to be avoided. It is not enough that the passages on the pulley end of the bearing be free, but the back ones must be kept open also, since all the oil will eventually flow to the end of the bearing that is stopped up and to the outside.



[illegible] Trouble Bearing

Public Water Supplies in Illinois

Present Situation Reviewed in Paper Presented March 29, at Annual Meeting of Illinois Section of American Waterworks Association

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Public water supplies have been installed in 449 municipalities. In addition records have been obtained of the public water supplies at 10 unincorporated communities, at the 28 State institutions and the 7 Federal institutions, army posts, and naval stations in the State, making 494 in all.

The Federal census shows that for the past three decades the proportion of the population in Illinois in municipalities of 2,500 and over was 54.3 per cent, 61.7 per cent, and 67.9 per cent. It is felt that municipalities of even less than 2,500 should be considered as urban instead of rural, as defined in the Federal census reports, and especially is this true when considering public water supplies, for under ordinary conditions a community having a population of only 300 or perhaps less might well have public water-supply installations as well as other public utilities and improvements.

Ordinarily the term "public water supply" is applied to a supply serving a community whether or not such community is incorporated, but in the remainder of this paper the term will be limited to supplies for incorporated communities, and the 10 unincorporated communities that have public supplies and the State and Federal institutions will be omitted.

One Thousand One Hundred and Eleven Possible Public Water Supplies.—According to the 1920 Federal census the total number of public water supplies, for incorporated communities, that would be possible in Illinois is 1,111, for there is that number of municipalities, of which 259 are incorporated as cities, 31 as towns, and 821 as villages.

The distribution of population among the municipalities of different sizes is presented in Table I. This table shows that Chicago has about two-fifths of the entire population of the State, that 939 of the total of 1,111 municipalities, or 84 per cent, have only one-tenth of the population, that about one-fifth of the population live in unincorporated areas, and that the remaining three-tenths of the population are distributed comparatively evenly among five groupings of municipalities by population.

Rate of Development of Public Water Supplies.—The number of public water supplies that have been installed in mu-

TABLE I.—DISTRIBUTION OF POPULATION AMONG MUNICIPALITIES

Population classification	Number of municipalities	Population	Per cent of total population.
1,000,000 or more	1	2,701,705	41.5
50,000-100,000	4	267,722	4.1
25,000-50,000	12	432,588	6.7
10,000-25,000	27	406,143	6.3
5,000-10,000	47	324,046	5.0
2,500-5,000	81	273,474	4.2
Less than 2,500	939	678,312	10.5
Unincorporated areas		1,401,290	21.6
Entire state	1,111	6,485,280	100.0

TABLE II.—NUMBER OF PUBLIC WATER SUPPLIES INSTALLED BY YEARS

Year	Number of supplies installed: Each year	Number of supplies installed: Total	Year	Number of supplies installed: Each year	Number of supplies installed: Total
[illegible]	1	1	1895	31	218
[illegible]	[illegible]	[illegible]	1896	15	233
[illegible]	4	[illegible]	1897	11	244
[illegible]	1	8	1898	17	261
[illegible]	[illegible]	8	1899	5	266
[illegible]	2	10	1900	17	283
[illegible]	1	11	1901	3	286
[illegible]	3	14	1902	12	298
[illegible]	3	17	1903	5	303
[illegible]	[illegible]	17	1904	9	312
[illegible]	1	18	1905	11	323
[illegible]	[illegible]	[illegible]	1906	6	329
[illegible]	[illegible]	[illegible]	1907	9	338
1881	[illegible]	[illegible]	1908	8	346
[illegible]	1	[illegible]	1909	6	352
[illegible]	[illegible]	[illegible]	1910	8	360
[illegible]	[illegible]	[illegible]	1911	16	376
[illegible]	11	[illegible]	1912	10	386
[illegible]	[illegible]	[illegible]	1913	9	395
[illegible]	11	[illegible]	1914	12	407
[illegible]	[illegible]	[illegible]	1915	21	428
[illegible]	[illegible]	[illegible]	1916	9	437
[illegible]	11	[illegible]	1917	4	441
[illegible]	13	[illegible]	1918	3	444
1892	[illegible]	144	1919	..	444
[illegible]	17	161	1920	4	448
1894	26	187	1921	1	449

nicipalities in Illinois and the rate of such development are presented in Table II. This shows a fairly uniform and rapid rate of increase in the number of supplies, beginning about 1885 and continuing until about 1916. The decrease in rate beginning with 1916 probably is the result of war conditions.

General Classes of Public Water Supplies.—Public water supplies in Illinois may be divided into three general classes: (1) those obtained from surface sources, (2) those obtained from drift wells, and (3) those obtained from rock wells. There are in addition sources such as springs, abandoned mine shafts or workings, but supplies from such sources can be classified with the drift or rock well supplies, depending upon the formation from which the waters are derived. In general, the supplies for the northern portion of Illinois are obtained from rock wells and most of these wells penetrate St. Peter or Potsdam sandstone. The majority of the supplies for the central portion of Illinois are obtained from sand and gravel forming part of the glacial-drift deposits. Nearly all of the supplies for the southern portion of Illinois are derived from surface sources, for in that section supplies from wells would be either inadequate or so highly mineralized as to be unsatisfactory for general domestic purposes.

Table IV presents the number of public supplies obtained from the three classified sources and the population (1920 Federal census) served by such supplies.

This table shows that although only one-fifth of all the public supplies have surface-water sources, these surface supplies serve about three-fourths of the entire population served by all public water supplies. This is, of course, because the large population of Chicago served by Lake Michigan water and also the municipalities north, south, and a few to the west of Chicago that are also served by Lake Michigan water, influence this relationship. There are slightly more rock-well supplies than drift-well supplies, but the average population served per supply is about the same, namely, about 3,000.

TABLE III.—POPULATION SERVED BY PUBLIC WATER SUPPLIES BY DECADES.

Year	Population: Entire State.	Population: Excluding Chicago.	Population served by public supplies: Entire State.	Population served by public supplies: Excluding Chicago.
1840	476,183	471,713	4,470	0
1850	851,470	821,507	29,963	0
1860	1,711,951	1,602,691	109,260	0
1870	2,539,891	2,240,914	339,190	40,213
1880	3,077,871	2,574,686	662,882	159,697
1890	3,826,352	2,726,502	1,660,327	530,577
1900	4,821,550	3,122,975	2,797,620	1,999,115
1910	5,638,591	3,453,308	3,696,751	1,511,468
1920	6,485,280	3,783,575	4,696,381	1,994,676

TABLE IV.—NUMBER OF PUBLIC WATER SUPPLIES CLASSIFIED BY SOURCE AND POPULATION SERVED BY EACH CLASSIFIED SOURCE.

Source of supply.*	Number of public supplies.	Population served 1920.
Surface water	95	3,541,440
Drift wells	159	515,640
Rock walls	195	639,301
Total	449	4,696,381

*There are 8 municipalities, having a total population of 57,404, that have combined rock well and surface supplies; 4 municipalities, having a total population of 29,029, that have combined drift well and surface supplies; and 16 municipalities, having a total population of 65,687 that have combined rock and drift well supplies. Each of these 22 places have been included in one of the three classified groups in accordance with which source of supply constitutes the major source of the total water used.

TABLE V.—TOTAL POPULATION AND PERCENTAGES OF POPULATION SERVED BY CLASSIFIED SOURCES OF PUBLIC WATER SUPPLIES

Population-source classification.	Population and Per Cents. Including Chicago	Population and Per Cents. Excluding Chicago
Population of all municipalities in State	5,083,990	2,382,285
Population served by public water supplies	4,696,381	1,994,676
Per cent of population in all municipalities that are served by public water supplies	92.5	83.5
Population served by surface supplies	3,541,440	839,735
Per cent of population served by public water supplies that are served by surface supplies	75.4	42.1
Population served by drift-well supplies	515,640	515,640
Per cent of population served by public water supplies that are served by drift-well supplies	11.0	25.9
Population served by rock-well supplies	639,301	639,301
Per cent of population served by public water supplies that are served by rock-well supplies	13.6	32.0

TABLE VI.—NUMBER OF MUNICIPALITIES THAT DO NOT HAVE PUBLIC WATER SUPPLIES ARRANGED BY POPULATION GROUPS.

Population group.	Number of municipalities without public water supplies: For group.	Number of municipalities without public water supplies: Total.	Population for each group.	Total population.
5,000 up	1	1	5,580	5,580
3,000 to 5,000	7	8	26,190	31,770
2,000 to 3,000	9	17	21,896	53,666
1,500 to 2,000	16	33	27,225	80,891
1,000 to 1,500	56	89	68,005	148,896
750 to 1,000	64	153	52,481	201,377
500 to 750	120	273	72,005	276,382
400 to 500	91	364	41,047	317,429
300 to 400	109	473	38,126	355,555
Under 300	189	662	32,054	387,609

Table V analyzes the distribution of population served by public water supplies as regards classified sources.

Municipalities That Do Not Have Public Supply.—This table shows that 92.5 per cent of the population of all incorporated communities are served by public water supplies. Since only 449 of the 1,111 incorporated communities have public water supplies, more than doubling the number of public water supplies would increase the population served by public supplies less than 10 per cent.

The distribution of those municipalities that do not have public water supplies is presented in Table VI, according to population groups. The largest municipality that does not have a public water supply is Zion City (1920 Federal census, 5,580). There are more municipalities having populations of over 300 that do not have public water supplies than there are municipalities that have already installed such supplies, but the total population not served is comparatively small. Installing public water supplies in the 89 cities having populations of 1,000 or more which do not now have public water supplies, would reduce the total population of municipalities not now served by public water supplies one-third.

Need for New Waterworks and Improvement of Old Ones.—A large number of new public water supplies should be installed in Illinois, but the magnitude of the work of such installations will be small in comparison to installations already made. In addition to the new supplies that should be installed there remains a large amount of development to be done before many of the existing public water supplies in Illinois can be considered to be what they should be from the standpoint of domestic service, fire protection and health and sanitary conditions, and the additions and improvements to these existing supplies probably will require considerably more work and expenditures than the installation of supplies in the municipalities now without public water supplies.

In discussing the population served by public water supplies the total population of each municipality has been considered as served, but in reality there are quite a number of municipalities where only a portion of the population actually use the public supplies, and there are some where only a few people really use the supply. This limited use of many public water supplies is because of limited extension of mains in some municipalities, the inadequacy of the supplies in others, and the unsatisfactory quality of the supplies for domestic purposes in those municipalities where the supplies are scarcely used, except for fire protection.

The inadequacy of the supplies in some municipalities is the result of increases in populations, in others the decreased yields of the sources, and in some instances the supplies have never been adequate for mone than parts of the populations, and as the number of service connections increased the inadequacy of such supplies have been locally realized. With but few exceptions where the supplies are of unsatisfactory quality they have been so since their installation.

Large Amount of Water Supply Development Work Yet to Be Done.—The enlargement and improvement of existing public water supplies combined with the installation of supplies in municipalities as yet without such supplies represents a very large amount of work for engineers and others interested in water-supply developments, even though the population of the State does not increase. With the increase in population of the State that can be expected and the noticeable increasing desire of the people for better and more adequate public water supplies, the water-supply development work to be done becomes very great.

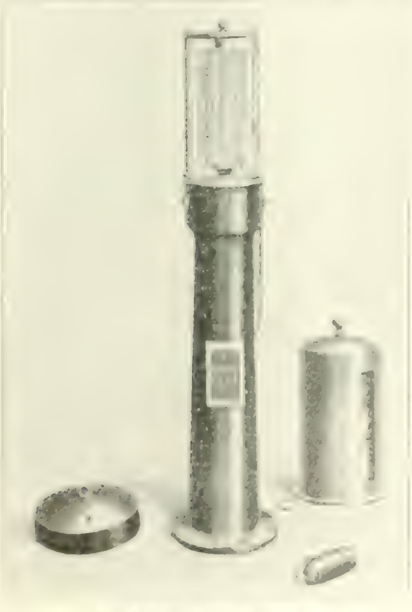
The size of the community that might well have a public water-supply system cannot be definitely stated. Communities of even a few dwellings, in those areas in Illinois where supplies can be obtained from rock or drift wells at comparatively low cost, might to the advantage of all property owners have public water-supply systems. The installation and operation cost of a single pumping outfit would be less than would be the cost for several private running water supply installations, and this saving would tend to offset the cost of a distribution system and the remaining cost of the distribution system would be cheap fire and health insurance.

It must be remembered also that a [illegible] portion of Illinois [illegible] all public [illegible] for [illegible] northern Illinois. [illegible] frequently the [illegible] only [illegible] In [illegible] not [illegible] on the larger municipalities [illegible]

An Audible Water Level Recorder

From Water and Water Engineering, London.

The usual method of giving warning when certain water levels in reservoirs have been reached is to employ an electrically operated alarm bell brought into action by a float rising and falling with the [illegible]. This system proved for [illegible]



The Audible Water Recorder

[illegible] high or low water levels. A step further was to transmit a record of levels along private lines and the installation of special instruments for transmitting and receiving these signals.

Kent's "A" type audible level indicator, however, goes a step further still and uses the public telephone lines. The instrument being connected to the telephone exchange in the same way as if it were a subscriber, and anyone interested and knowing the telephone number allotted to the instrument can ring up and receive audible notice of what quantity of water is in the reservoir, well, etc. Only a transmitter is thus needed, as the ordinary standard telephone acts as a receiver.

[illegible] chance of error are [illegible]

The standard instruments are made to give 100 different readings, for example, to record from 1 ft. to 99 ft. by 1 ft. distances. Of course, it is possible to have more readings by adjusting the instrument. Indication of the level is given by a series of clicks, and this signal is repeated three times, thus eliminating any possibility of error in reading. The same instrument could be adapted to indicate over the telephone readings of dials and scales of any kind.

The mechanism of the instrument is briefly as follows:

By the movement of a float a contact arm is moved parallel to the axis of a drum. When the telephone exchange rings up the instrument, the clockwork train is set in motion and the drum rotated. The contact arm makes electrical contact with the drum during its revolution, thus causing a series of sounds to be imparted to the circuit. A special selecting gear is provided to ensure that once the machine is in motion the arm cannot alter its position until the revolution is complete.

Assume the level in a reservoir is 15 ft., what one would actually hear on the telephone would be a series of clicks in the following sequence:

— — -   — -

It will be seen that the signals are sent in groups of three, and that a longer pause is set between the digits. This system is the easiest to read. After repeating the signal thrice the telephone line is automatically cleared and the instrument is again ready to be called up as and when required.

The instrument is entirely closed and locked up. The scale or dial, however, is visible at all times. As regards price, this has been set provisionally at £75 ($365). Another type of this instrument employs a gramaphone so that instead of clicks one hears in actual words the exact reading. This type is unique in the fact that if a danger point is reached it rings up the engineer itself.

The invention has been patented by Mr. Deane-Butcher, and is constructed by Messrs. George Kent, Ltd., 199 High Holborn, London, W. C.

Fuel from Sewage Grease

From Water and Water Engineering, London.

The Scottish Board of Health suggests that in order to provide for future developments in connection with water supplies to certain districts in North Ayrshire it would be advisable for the local authorities concerned to consider the question of combination.

Experiments have been made at the Birmingham sewage works at Esholt to ascertain how far the recover sewage grease may be utilized for fuel. The Sewage Committee has in the vicinity of the works a stack of coal many acres in extent and 6 ft. deep, the weight being thousands of tons. The idea has been conceived of combining the smudge from this coal with the grease taken from the sewage, and the result is very promising. A briquette somewhat in the form of an egg has been made, and this has been found to be very successful for firing boilers. Many thousands of tons of the briquettes have been placed on the market, and a big demand is anticipated for them if the coal trouble is prolonged, and probably afterwards.

Specific Heat.

The specific heat of any material is the number of B.t.u. required to raise the temperature of one pound one degree Fahrenheit. By the definition of a B.t.u. the specific heat of water is, of course, equal to 1. The specific heats of some well known substances are approximately as follows: Aluminum, 0.21; copper (cast), 0.095; brass, 0.094; brickwork, 0.20; cast iron, 0.13; steel, 0.12; wrought iron, 0.12.

As an example of the use of these constants suppose that it is desired to find out how much heat will be absorbed by 1,000 lb. of wrought-iron piping at 70 deg. Fahrenheit, if steam at atmospheric pressure is admitted to it. On the admission of the steam the temperature of the pipe will rise approximately to 212 deg. Fahrenheit (the temperature of the steam). The temperature rise is 212 — 70 = 142 degrees. To raise one pound of wrought iron one degree, 0.12 B.t.u. is required. Therefore the heat required to raise 1,000 lb. through 142 degrees will be 1,000 × 142 × 0.12 = 17,040 B.t.u. About 17 lb. of steam would be condensed in heating up the pipe, assuming that a pound of steam gives up about 1,000 B.t.u. on condensing.—Power.

How to Improve Relations Between Public and the Utility

Abstract of a Paper Presented at Recent Convention of Tri State Light and Water Association

By O. H. BESSELL

There is one broad principle which I think may be applied with good result—always treat the public with perfect candor, putting forth every effort to gain its confidence; let everything be open and above board. Every consideration within reason should be shown the individual and every effort made to make him feel that you are not only glad to serve him but that you have his interests at heart. This rule when applied to the individual permeates the whole body like leaven and lays a foundation for a kindly feeling and good will which is a prerequisite to the successful handling of the people, and will tend more than anything else, I believe, to overcome the prejudice and antagonism which exists.

Three Qualifications for Handling Public.—There are three qualifications necessary, in my experience, to in any way successfully handle the public. First, self-control; second, some knowledge of human nature, and third, what we may call an instinctive perception of the kind of individual you have to deal with. It is well, also, to try to impress him with the feeling that you are interested in his side of the question and that you sympathize with him. Try and keep your temper always, and if possible let him get the idea at the start, at least, that he is right. This attitude on your part avoids friction at the beginning, which friction is hard to get rid of after it has been set up. A weakness of human nature is that most of us like to feel that we are right in our conclusions and judgment, and once you have gratified this egotism it is more easily handled.

It goes without saying that courtesy and politeness are necessary assets, but by means of this instinct, or intuition, if you please, you sometimes discover that the end is better served by being not so polite; for some people take ordinary courtesy and politeness to be an indication of servility, and need to be checked at the start and given to understand that while you may be a public servant yet you have some rights which he is bound to respect.

Sizing Up the Individual.—The person dealing with the individual must size him up and work him according to his best judgment, as to his disposition, and general makeup, and to this end it is best, as suggested before, to let him believe at first that his side of the question is right, for this will give you time to take his measure and handle him accordingly. It has been my experience that there are times when it becomes necessary to be apparently rude and dogmatic, but you must be reasonably sure of your man. This knowledge I believe is not easily acquired by experience, if ever; but rather seems to be instinct, or perhaps intuition would sound better.

There is, for instance, the fire-eater who stalks into the office with "blood in his eye," having fully made up his mind on his way there to mop up the floor with someone if he does not get just what he wants, but who if handled with the judgment or instinct, or intuition referred to, goes out as mild as "a May morning" without having accomplished what he came for and many times a wiser and better man. The party handling such an individual should possess this instinctive knowledge of human nature to a degree; in one case it may be best to be exceedingly polite, letting him have all the rope he wants until he runs out, and again it may be thought best to meet him with a belligerent attitude and give him as good as he sends; but as I have said, there is no rule which can be universally applied. It is a matter of what I call intuitive judgment.

Handling the Cocksure Individual.—Then there is the individual who has carefully gone over the details of his case and built up such an unbroken chain that he is cocksure that he has you tied hand and foot and entirely at the mercy of his logic and reasoning; he should be handled in an entirely different manner. It may be best to let him think that he knows it all, taking care not to tell him that he does not in so many words, but gradually let him see this for himself by means of the facts you set before him. In other words, give him the milk but don't let him see the bottle he is drinking out of.

Then there is the well disposed and mild mannered gentleman who comes to the desk with a smile and an open mind, seeking information. He gives polite attention to what you say, thanks you for your trouble and information, goes out with a smile and a pleasant good day, leaving you with the feeling that life is worth living after all.

Then there is the argumentative type who would rather argue with you than eat, and all you are able to get out of it when he has finished, if he ever finishes, is, that it is for the sake of argument; for this individual there is but one way, give him all the rope he wants and thank God when he is through.

The Female of the Species.—Last but not least in this category is the female of the species, which is said to be "more deadly than the male." What shall we say about them? I believe the least said the soonest mended, would be a good rule to follow, but we cannot dispose of them in such a summary manner. They are with us and we must handle them. I believe in the handling of the ladies we can come nearer observing a fixed rule with good results than with any other phase of the question—always be polite, and if possible never contradict. You may differ with them all right, but never contradict or attempt to argue—it can't be done, you are beat before you start, and if you are not willing to concede that you are beaten in the argument before you start you will discover if you are not more than careful in your speech, that you are likely to be beaten literally by some other fellow when you have finished.

There is an accepted rule in mercantile life, I believe, which says the salesman is always wrong and the customer right. While this may be hard on the salesman, it is doubtless good business for the merchant, in that his chief object is to hold his customer on account of competition, and then he always has a chance to get even after he has pacified him; but in the handling of the business of a public utility, such utility at least as I have had experience with, I believe it is a good and necessary rule to back up the employee to the limit. This of course is taking it for granted that the employee is a trustworthy person. This attitude towards the employee by the company creates a sympathetic and hearty interest and a co-operative spirit in him, and at the same time has a beneficial effect upon the public.

The Privately Owned and Public Utilities.—There is a great difference in the handling of the public from the standpoint of a privately owned utility, and that of a municipally owned utility. In the matter of adjusting high bills and other complaints where the utility is privately owned, it is much easier to pacify the consumer; for you are bound by no inviolable rule but have the right to discriminate even to the extent of remitting the entire bill should you see sufficient cause, and feel disposed to do so; and so also with other complaints for you have a greater latitude. While with the municipally owned utility you cannot discriminate, it matters not how much the case may appeal to you, as long as it comes under the rule; for you must apply the rule in every case without favor. Each consumer feels that he owns the utility and that his case is just as deserving of a compromise as the other and you cannot afford to be the judge. Since the plant belongs to the people all must be treated alike and the consumer thinks that he is the best judge, so you can only stick to the rule. This is an advantage in many ways, for while the consumer kicks and damns the rules and raises cain about it, it is his utility and the rule governing his case is his rule, so to speak, and practically amounts to law, so you can apply it and "sit still in the boat."

Some Experiences with Kicks Against High Water Bills.—It may be interesting, particularly to those who are in the water business, for me to relate some of the experiences which we have, especially as to discovering the cause of high bills, and pacifying the kicker. Of course, every man thinks that his troubles are worse than the other fellow's, but I think that I can say without fear of contradiction, that in the matter of wasting the commodity furnished without the knowledge of the consumer, there are more ways of wasting service in the water business than is possible in either gas or electricity. For instance, a consumer's bill will run below the minimum charge in consumption for six months or more and then jump to four or five times the minimum. You are called on to explain. Of course you have the meter re-read, find the reading correct; you examine the fixtures, find them perfectly tight; you watch the meter indicator dial and find that it does not move, you are up against it; the consumer sweats conditions are the same as usual and you cannot explain it.

Again the bill jumps to twice its normal average, the re-reading of the meter shows that the daily consumption in the interim between the reading for the billing and the re-reading is just about the same as the daily consumption for the bill period. Of course this is good evidence of a wasting going on; this is easy, for notwithstanding the fact that you are told by the consumer that a plumber has just gone over his fixtures and found nothing wrong, if you have had sufficient experience you will be able by careful investigation to discover an overflow or outlet seepage, which the plumber more frequently than otherwise overlooks, and by timing the movement of the meter with your watch you may convince him that the water has been wasted. I will relate an experience which came to me when we first began to meter which will explain the first instance cited, where no reason could be found for the high bill.

A certain Mr. A., a prominent business man of our city, who was very much exercised as to the effect metering would have on his financial condition, requested that he be taught to read the meter so that he could keep a daily record of his consumption. This was done. He had been informed that with due care the meter would be less than his flat rate. At the end of the first month his bill on the meter amounted to $[illegible]. He had been enjoying a flat rate of $9.50 per quarter. When this bill reached him he telephoned for me. On entering his office he said to me with some apparent heat, "You are a h[illegible] of a fellow, you told me my bill would be less on the meter and here I have a one month's bill which is larger than the bill for the quarter." I asked him where his record was that he had been keeping and with a twinkle in his eye he handed it to me; it showed that for 20 days the consumption was very normal, then the record ceased; I asked him why he had not kept it for the full period; he replied it was running so smoothly that he thought there was no need; but he said it won't catch me next time. On the 15th of the following month he called to me to come to his office, and on reaching the office he handed me the record; for 14 days there was a perfectly normal consumption, and then it jumped to four times the amount; I asked him what had happened. He said, "Well, when I saw that jump, I thought the meter was crazy; however, I proceeded to investigate and discovered that the faucet in the chicken yard which was over a drain pit had been left open by the cook." "Well," I said, "Mr. A., this is splendid, for it shows just what you are up against. Had you not discovered this you would have said that the plumber could find nothing wrong on your premises and I would have been able to find nothing wrong, and even though the meter had been tested for your satisfaction you would not have been satisfied." It is needless to say we have never had a complaint from Mr. A. since.

When such things as this occur you are up against a hard proposition, for to speculate or theorize won't do—you have got to put your finger on the trouble, and the customer says, "I have had a plumber go over everything, he finds nothing wrong, you have examined everything and find nothing wrong, conditions have been the same, consequently your bill must be wrong."

It is not always an easy matter either to reach the individual so as to explain. Only a short while ago one of our csutomers had a very high bill; she requested a re-reading of the meter, and when the meter reader went to the house she met him, watched him read the meter, and when he announced that the meter was going at the same rate of consumption as the bill period, she informed him that he did not know his business and ran him out of her yard. I had the pleasure of attempting to pacify this individual.

The location of leaks in order to account for high bills does not constitute all of our troubles. You must explain why they don't get water at times when your pressure gauge shows a maximum pressure; often you find, to your disgust, after you have taken the trouble to investigate, that some of their own people have shut off the water at the stop and waste cock. You must explain also why the water shows high color today and did not do so yesterday, etc., etc.

Portland Cement Association to Meet June 27 and 28.—A regular meeting of the Association will be held on the dates named at Hotel Traymore, Atlantic City, N. J. Several technical papers will be presented.

The Efficiency of Irrigation*

By G. E. P. SMITH,

Professor of Irrigation Engineering, University of Arizona

In these days we hear much about efficiency. There is such a thing as efficiency of irrigation. It may be defined as the ratio of the water beneficially used to the total water diverted onto the land. The water beneficially used is the water that is actually drawn upward by plants (not including weeds) and is transpired through the stomatal openings into the atmosphere. The transpiration of plants is far greater than most of us imagine. The U. S. Department of Agriculture tells us that alfalfa transpires about 1,000 lb. of water for each pound of hay produced. It is the water gourmand, other crops requiring considerably less. The losses of water are by evaporation from the soil direct, by seepage downward beyond the reach of plant roots and wilful or careless waste, which includes irrigating the county highway. These losses aggregate from 10 to 80 per cent of the water applied, depending on the method of irrigation and how well the irrigation is performed.

Water Losses from Canals and Ditches.—Another loss of irrigation water is by seepage and evaporation from canals and ditches; this, the greatest loss of all, should not pass without comment. Nearly all of this loss is by seepage. Measurements of the seepage losses on scores of canals and ditches have been compiled and published. The results are startling. Losses of over 10 per cent of the water per mile of ditch are not infrequent, and it is concluded that "a large percentage of the water, estimated at 40 per cent of the amount taken in at the heads of the main canals, is lost by absorption and percolation along the routes." The records of the U. S. Reclamation Service in the Salt River Valley state that the canal losses between the diversion dams and the points where water is delivered to the water users have been from 40 to 45 per cent of the total amount diverted. While the losses as given in the records may be overstated somewhat, it is certain that at least one-third of the water diverted is lost in the canals. The loss from the Avondale Canal is 40 per cent in the first four miles.

No practical method of preventing canal losses has been found except by the use of concrete linings for large canals and cement pipe for small canals and for farm ditches. Linings and cement pipe lines have been highly developed as to permanency and efficiency, and the cost is so low as compared to the value of the water saved that it is only good business economy to make the investment. Linings and pipe lines have many additional advantages. They may obviate the need of an expensive drainage system to prevent waterlogging; ditch cleaning is eliminated; breaks, especially those caused by gopher holes and the tramping of stock, cannot occur; the labor cost of irrigating is greatly reduced; and pipe lines permit of running the lines through low ground instead of following contours around the low places.

Ways of Reducing Evaporation Loss.—For the losses which occur in the transportation of water, irrigation associations and the land owners must divide responsibility, but for the losses which occur after the application of the water to the land, the farmers are responsible individually.

There are many ways by which the evaporation loss can be reduced. Some of them are deep plowing, frequent cultivations, use of fertilizers, reducing the frequency of irrigations, and irrigating at the right time. Windbreaks also tend to reduce the evaporation. The land should be thoroughly irrigated before planting; "irrigating the seed up" is an unfortunate practice. Where the soil is deep and retentive, one thorough irrigation of alfalfa per cutting is better than two; it should be applied about eight or ten days before cutting and not just after cutting. On light soils two and sometimes three irrigations per cutting are required; the irrigation should be light. If two irrigations are given, one should be given when the alfalfa is about 5 in. high and the other about five days before cutting. It is assumed that at those times the color of the alfalfa will be darkening noticeably, but that the leaves have not begun to show wilting.

Loss of Water by Seepage.—The loss of water by seepage is the hardest one with which to deal. The extent of this loss is not apparent from surface inspection, and the remedies are not obvious. To prove that the loss exists and is large is not difficult. Nearly all irrigation projects soon encounter difficulties due to the rise of the water table, causing or threatening alkali troubles and waterlogging.

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*From Bulletin issued by the University of Arizona.

On most soils it is inevitable that there should be some seepage downward and in districts where the irrigation water contains considerable alkali or the soils are naturally alkaline, a moderate degree of downward percolation is desirable in that it prevents the accumulation of the alkali in the surface soil, but ordinarily the seepage loss is excessive and is unjustified from any standpoint. The seepage may be due to general over-irrigation, too heavy and too frequent applications of water. More often, I believe, it is due to the unequal distribution of water over a field. While the irrigator endeavors to get sufficient water to one part of the field, another part receives such an excess that a large portion of it seeps downward beyond the reach of the root system. On lands that take water readily, many cases have been observed where the head ends of the lands receive water for from one to three hours, while the tail ends receive only a dribble, and that for only a few minutes. Surely, this is not an ideal irrigation.

Uniformity of Distribution of Irrigation Water.—Several years ago, the writer made some investigations to determine the uniformity of distribution of the irrigation water. In one case, on heavy loam, it was found that the average percentage of soil moisture at the head of a land, for six feet depth, was increased from 24.1 to 26.3 per cent by a 4-in. average irrigation, while at the tail end the soil moisture was increased from 15.4 to 18.2 per cent. In another case on sandy loam the soil moisture at the head end was increased from 14.3 to 21.1 per cent and at the tail end from 8.3 to 12.2 per cent. In both cases, therefore, the head end had more soil moisture before irrigating than the tail end had after irrigating—a preposterous condition. Inasmuch as the alfalfa near the foot of each land was making excellent growth, it follows that the head ends of the land were getting unnecessarily large, wasteful amounts of water. On one of the fields thus tested the average depth of water applied in 1914 was 108.2 in. Unquestionably, 50 per cent of the water thus applied sank to the water table and was wasted. Many similar cases have been observed where the quantity of water absorbed at the head ends was found to be excessive and wasteful. When these conditions exist, the remedy is less water more rapidly applied, by means of a larger head, or shorter runs, or steeper slopes.

Slope of Land and Head of Water.—The problems of what slope to give the lands and what head of water is best are inter-related, and involve also a discussion of the length and width of lands, and the character of the soil. Any one of these five factors can be taken as a function of the other four factors. The problem is complex and should be solved separately for each crop, and for each locality.

In some communities, the solution is thought to be the grading of the lands level, or on a very slight gradient, which entails an additional expense of $20 to $40 per acre. This outlay is of doubtful utility. In the writer's opinion the lands should be graded down the natural slope or approximately so. Surely any lands with slope from 3 to 40 ft. per mile and with good soil can be laid out and irrigated without material change in the general direction of the slope.

The other factors, then, can be determined so as to give the most uniform distribution of water. Thus, on light soil with a grade of 20 ft. per mile, where a large head of water is available, perhaps the lands can be laid out 50 ft. wide and 880 ft. long. If the head of water is small, as from a No. 5 centrifugal pump, then the lands should be not over 30 ft. wide and 440 ft. long. If, however, the grade is only 10 ft. per mile, the lands, perhaps, should be 660 ft. long for the large head and 330 ft. long for the small head.

These values are intended to be suggestive; on shallow soils underlain by caliche the lands can be longer; in some cases lands 1,300 ft. long are irrigated successfully. For heavy loams the lands can be considerably longer than for sandy soil, and in general the flatter the grade, the shorter should be the runs and the larger should be the head of water. Heavy, or "hard," soils are found usually on flat slopes, as from 5 to 10 ft. per mile. In the latter case, the lands may be as long as ¼ mile, but they should be narrow, say 36 ft. wide, so that a small unit head can be made to cover the width uniformly.

Uniformity of Distribution.—The final adjustment to obtain an even distribution should be made by varying the head of water in each land. This adjustment should be made last because it is the easiest to make. Recently an irrigator near Mesa, Ariz., complained that the stand of alfalfa was better in the lower part of his field than in the upper part. He wished to regrade the field so as to reduce the fall. But the remedy was much simpler than that. His head of water delivered by the Reclamation Service was 300 miner's inches. By changing his order and obtaining 275 miner's inches he would get a uniform irrigation and uniform crop. Many irrigators have difficulty in getting the water across their land. They require a larger unit head. They should order more water, or concentrate it in fewer lands, or if this cannot be done without increasing the unit head to a point where it will erode the soil, then the length of run should be reduced.

Uniformity of distribution is possible, but requires thought and skill and probably some investigation on the part of the irrigator. Every irrigator should use a soil auger or a shovel to ascertain the penetration of the water and the condition of the soil, at least to 5 ft. depth, before and after an irrigation. This should be done near the head end, near the center, and near the lower end of one or of several lands. It would be folly to lay down general rules for the lengths of lands, the slope, the desirable heads of water, or the frequency of irrigations. Much good sense and judgment must be exercised. Even variations of climate may vitiate a rule.

Duty of Water.—As to the total quantity of water required for a crop in a season, little will be said here. The amount of water applied per acre is called the duty of water, and is best expressed by stating the number of acre-feet of water per acre per year. In many localities, however, the duty is stated as the number of acres per miner's inch or per second-foot, or the number of miner's inches per quarter section of land.

Alfalfa requires more water than any other common crop, and alfalfa is the best basis for study and for comparison between different practices inasmuch as it is grown extensively on all varieties of soil and in all altitudes and climates.

The most elaborate duty of water investigations have been made in Idaho and California. In Idaho, Don H. Bark, after investigations covering four seasons and costing $60,000, published many definite conclusions, one of the most interesting of which is that the economic irrigation of alfalfa, in Idaho, on good loam soil, in an irrigation season of a hundred days requires three acre-feet of water per acre. The investigators of the California Agricultural Experiment Station have concluded that, in the Sacramento Valley, alfalfa should receive from 30 to 36 in. depth of irrigation, the first cutting and sometimes the first two cuttings being obtained before any water is applied. In Arizona the irrigation season is over 200 days in length, and investigations show that there is about as much increase in crop in the application of the seventh or eighth acre-foot per acre as in the third or fourth, and the rate of increase is a little over a ton of hay per acre-foot applied. One record in the Casa Grande Valley in 1918 showed 22 irrigations of about 5½ in. depth each. The owner claimed that he cut 13 tons per acre, and the county agricultural agent maintained that the record was correct. There seems to be almost no limit to the amount that can be beneficially applied to alfalfa, but excessive amounts cannot be recommended or tolerated because of the rising ground-water plane that inevitably results.

With other field crops, however, there is an optimum amount that should be applied, and if a larger amount is used, the crop yield is actually reduced. Cotton requires from two acre-feet on medium loam soil to three acre-feet on light sandy soil and on new desert soil, and milo maize requires even less. Rice, in the Sacramento Valley, requires from four to five acre-feet per acre.

In comparing records of the water used in different localities, it is found that the duty of water is much higher when the water is delivered and charged for on a measurement basis than when the irrigator pays a fixed price per acre per season. In places where the basis of payment for water has been changed from the flat rate to a definite sum per acre-foot, the quantity of water used by farmers has decreased at once. Rotation of water, also, results in a marked saving over the older practice of continuous flow to each water-user, a practice that still obtains in the more northerly irrigated states.

Not the least important among the factors determining the acreage that can be served by limited water supplies are the character of state laws and the attitude of judges and others charged with the disposition of existing water rights and of new appropriations of water. [illegible] are unfortunate in this respect. In [illegible] has been [illegible] in laws and court decisions. [illegible] the [illegible] water code, ditch owners help themselves from the [illegible] sources of supply, [illegible] appropriations, and the tendency is to apply water wastefully on the land in order to hold claims [illegible]. [illegible] in other states [illegible] [illegible] than [illegible] [illegible].

Cost of Sewage Pumping at Columbus, O.

The Division of Sewage Disposal at Columbus, O. operates two sewage pumping stations, the East Side Station and the Main Station. The service performed by the first mentioned is the pumping of the dry flow sewage and small amounts of storm water over the natural divide between Alum Creek and the Scioto and Olentangy Rivers. The equipment consists of a sand catcher cleaned by means of an orange peel bucket operated by a motor-driven hoist, vertical bar cage screens, duplicate 4,000,000 gal. horizontal direct connected motor-driven centrifugal pumps discharging into a 20 in. by 8,180 ft. cast iron force main, and a 20 in. by 7½ in. venturi tube with recorder and register equipped with oil seals.

The following data on the operations of this station and the Main Station are taken from the 1921 report of C. D. Mc[illegible], assistant chemist, Division of Water and Sewage Disposal.

OPERATING RESULTS EAST SIDE SEWERAGE PUMPING STATION FOR 1921 AND PREVIOUS YEARS.

Year	Total [illegible]	Per Cent of Time [illegible]	Per [illegible] Million Gallons	Mean Daily [illegible]	Mean [illegible]	Mean [illegible]	Total Annual Operating Cost	Mean Cost per Million Gallons
[illegible]	[illegible]	[illegible]	[illegible]	2.01	[illegible]		$[illegible]	$10.[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	18.2[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	17.38
[illegible]	[illegible]	[illegible]	[illegible]	1.90	[illegible]		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	13.17
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	10.86
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	10.49
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	13.17
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10,589.30	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.80	10,423.05	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	$13.67

[illegible]

[illegible]	$ [illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	1,418
[illegible]	9.5
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	63.0

The service performed by the main sewage pumping station is the pumping of the flow from any of the four sewers discharging into the suction wells to either the sewage treatment works or the Scioto River. The equipment consists of a sand catcher cleaned by means of an electrically operated stiff-leg derrick and grab bucket, vertical bar screens, 5 horizontal direct connected motor-driven centrifugal pumps with a rated capacity of 51,000,000 gal. daily, discharging into either a storm water force main [illegible] or a force main to the treatment works [illegible] and a 48 in. by [illegible] venturi tube with indicator and register equipped with oil seals.

During the year the screens were lifted [illegible] times and [illegible] wheelbarrow loads of screenings were removed. The pumps were flushed back [illegible] times during the year. This is [illegible] times per day or once for every [illegible] million gallons pumped. The static suction lift at this station is [illegible] ft., the static discharge head 18.5 ft. and the average cost of power $0.0125 per kilowatt hour. The operating costs were as follows:

OPERATING RESULTS MAIN SEWAGE PUMPING STATIONS FOR 1921 AND PAST YEARS

Pumpage in Million Gallons

Year	[illegible]	Per cent of [illegible]	Total	[illegible]	Maximum rate for 24 hours	Maximum for 24 hours	Total annual operating cost	Mean cost per million gallons
1910	[illegible]	[illegible]	[illegible]	[illegible]			$1[illegible],126.31	$4.16
1911	[illegible]	[illegible]	[illegible]	[illegible]			15,[illegible]	5.47
1912	[illegible]	[illegible]	[illegible]	[illegible]			11,2[illegible].89	6.17
1913	[illegible]	[illegible]	[illegible]				21,262.13	4.7[illegible]
1914	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].20	25.42	19,7[illegible].93	5.62
1915	242.30	[illegible]	[illegible]	[illegible]	[illegible]	31.52	17,37[illegible].57	3.37
1916	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	26.00	16,044.60	5.98
1917	[illegible]	[illegible]	[illegible]		[illegible]	26.84	18,409.82	4.48
1918	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	28.15	22,475.99	4.92
1919	227.15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	21,111.86	6.58
1920	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	23,411.21	5.61
1921	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	25,738.96	6.13
Means	[illegible]	[illegible]	[illegible]	[illegible]	36.00	31.[illegible]	$19,824.27	$5.14

Advantages in Applying Cement Mortar Under Pressure

Abstract in Concrete and Constructional Engineering from a paper read before the Association of Architects and Engineers of Munich.

The application of cement mortar under pressure is effected in two ways, as:

(a) A hole is bored into the material to be impregnated, and a slurry of cement mortar is pumped through the hole under pressure until the requisite quantity has been applied.

(b) The cement mortar is sprayed onto the surface, sufficient force being obtained by means of pressure applied to the slurry, as in a cement gun. More recently it has been found better to use a dry mixture of cement and aggregate and to apply water under pressure to the surface to be covered.

The chief difficulty in applying a liquid mortar lies in its tendency to become unmixed, while if a dry material is projected through a long hose by means of a stream of water, a considerable amount of setting may occur, and the hose may gradually become choked. Imperfect mixing of the solid and water may cause further difficulties.

In the "Tector" process, the dry materials are mixed and moistened so as to have the consistency of garden soil; that is, with one-third to one-half to the normal amount of water. The remainder of the water is applied at the nozzle of the machine but has only a pressure of about 7 lb. per sq. in., and so penetrates the moist mass quite readily. The hose pipe is never quite full of material, but has a current of air passing through it which breaks up the particles and facilitates the use of 100 yards of hose and enables chimneys and great lengths of tunnels to be worked without difficulty.

The advantages of applying concrete under pressure are:

1. The great density of the coat or lining produced.

2. Its resistance to water and its strength being much greater than stamped concrete. Slabs of ¼ in. when made by this process are completely impermeable to water under a pressure of 60 lb. per sq. in. (tests at higher pressures have not been tried).

3. The materials unite more firmly to old concrete and other materials than is the case with concrete applied by hand. When first concrete touches the old surface much of the coarse concrete falls off, leaving a film of cement mortar which rapidly fills all the cracks and irregularities in the surface to be treated, and adheres with extraordinary tenacity. As soon as the film has been formed the further concrete adheres fully to it, and produces a uniform coating of great adhesiveness.

4. Whereas with tamped concrete each layer is a source of weakness, when pressure is used no difference in strength occurs at the junction of the various coatings, nor can any junction be seen.

Some engineers have feared that concrete applied under pressure would spall readily, but this does not occur to any greater extent than when concrete is applied in any other manner. Under certain adverse conditions spalling will occur under any circumstances, but while precise numbers cannot be quoted, it seems certain that concrete applied under pressure is less likely to spall than ordinary concrete.

Railways and Excavation Monthly Issue

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Roads and Streets—1st Wednesday
(a) Roads
(b) Quarries and Pits
(c) Streets
(d) Street Cleaning

Waterworks and Hydraulics—2nd Wednesday
(a) Water Works
(b) Irrigation and Drainage
(c) Sewers and Sanitation
(d) Waterways

Railways—3rd Wednesday
(a) Steam Railway Construction and Maintenance
(b) Electric Railway Construction and Maintenance
(c) Quarries and Pits for Ballast and Concrete

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures

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A Proposed State Socialistic Experiment in California

How far California has drifted toward socialism will be pretty well indicated this fall when a statewide ballot is taken on the question of bonding the state for half a billion dollars with which to develop hydro-electric power and water for irrigation. Electrical World has recently taken a poll of the principal California newspapers, with the following results:

Favorable to the act	11
Opposed to the act	49
Noncommittal	42
Total	102

This seems to indicate that the proposed bond issue will fail. There is another reason for believing that it will not carry, namely, the experience of Los Angeles with its aqueduct and municipal electric power plants. Although Los Angeles is still in the experimental stage of municipal ownership, and is able to offer seemingly good excuses for not having yet accomplished the savings that were promised, a goodly number of its voters are beginning to have doubts. It is noteworthy that politicians who favor the $500,000,000 state experiment are not "pointing with pride" to the Los Angeles experiment. That is too near home. But they are pointing to Ontario, Canada, where a similar plan has been in operation several years. Unfortunately for the politicians, however, the Ontario experiment has recently been investigated by a competent American engineer who finds it to be an economic fiasco. Mr. W. S. Murray, former head of the U. S. Government Superpower Survey, has spent six months in Ontario gathering the necessary data for a report on the Hydro-Electric Power Commission of Ontario, and his conclusions will certainly carry greater weight than the guesses of politicians. Among other things equally convincing, he says: "The American companies in the Niagara district are supplied by steam power far more than those on the Canadian side, and yet on the American side power is being furnished at less cost to the people." In other words, the publicly owned plants of Ontario, which secure 87 per cent of their power at Niagara, are unable to undersell the privately owned plants at Niagara Falls, N. Y. In the Niagara district, the Canadian commission sells power at an average price of 9.25 mills, whereas the private companies sell in the corresponding American district for 7.6 mills per kilowatt hour, or 18 per cent less, in spite of the fact that the latter pay taxes and the former do not. The taxes in Ontario amount to 0.6 mill per kilowatt hour for electricity produced by private companies, so that if taxes were included the American private companies would be underselling the Ontario Government by 22 per cent in the Niagara district.

It will take a lot of speechifying to camouflage such facts, so we look to see California politicians drop the Ontario example and look for one in Australia, or Scotland, or wherever it is hard to ascertain the facts.

Who Is Responsible for Inadequate Railway Earnings?

In its recent rate decision the Interstate Commerce Commission speaks of 5.75 per cent as being a fair rate of return on railway capital. Most railway companies have so long suffered from even more inadequate returns than 5.75 per cent that probably many railway officials are prepared to offer thanks for that much, or rather for the prospect of securing that much some day. But where is there a business man in any kind of business who would regard his business as satisfactory if it normally yielded only 5.75 per cent on the investment? If, then, such a return is universally regarded by business men as being inadequate, why is it that no chambers of commerce, no associations of merchants, no manufacturing societies have yet passed resolutions condemning the Interstate Commerce Commission's decision that 5.75 per cent is an adequate return on railway capital? This long question can be answered in one short word—selfishness. Each person wants the other fellow to "hold the bag."

However, most men have a way of ceasing to "hold the has very long after its weight becomes onerous. Railway investors of the shrewder sort have long ago refused to send good money after bad, and the consequence is that steam and electric railway construction has been reduced almost to the vanishing point. Railway equipment and terminals are already inadequate to carry peak loads and every student of transportation knows that it will not be long before farmers, manufacturers and merchants will be damning the railways for not providing adequate facilities. Then it is that politicians will get payment in coin of their own vintage, for failure of the shipping public to assist railway owners in earning adequate profits will be almost entirely to blame for the failure of railways to provide adequate transportation facilities.

Without doubt it is temporarily popular to reduce railway rates, but how long will it remain popular? We trust that at least the business men of America will soon come to see that one of two things will surely happen if railway companies continue to earn inadequate profits: (1) Either railway facilities will grow worse or (2) government ownership of the railways will be forced upon the country.

Make the Valuation Reports Easier to Use

The value of any work may be measured by the use to which it may be put. Based on this premise the work of the federal valuation forces is falling far short of its possibilities and the Division is not fully discharging its obligation to the public. This work has now been in progress for nearly ten years and has cost the carriers and the Government over $80,000,000.

Tentative reports have been issued on nearly 200 properties and this number is being increased almost daily. Copies of these reports are being sent to the railways concerned, to the governors and the public service commissions of the states in which the properties are located, and to the attorney general of the United States. These, however, constitute only a small portion of those interested; the investors in the securities of the railways have a direct interest, as do the shippers and the public at large. In view of these vast expenditures of time and money it is important that the reports be presented in a manner which will enable these various interests to place the same interpretations upon the information and make them of the maximum value to all interested parties. This is not now being done. Undertaken originally as a means of protecting the public from the evils of over-capitalization then feared, the valuation work is now seen to afford protection to the investor.

The reports as now issued contain a vast mass of information concerning the properties which is bewildering to the average railway man, investor, or public officers, and is understandable only to the expert; moreover, because of their complicated make-up they may be misused to the detriment of public interest. Important and necessary as this information is, it would seem highly desirable for the commission which has prepared the report and collected the information incorporated in it, to summarize this information in a brief introductory statement in which there would appear those figures in which the vast majority of the people are interested. These include the commission's findings of value, including the property owned and used for transportation purposes, the land and buildings owned but not used for transportation, and other investments, in contrast with the capitalization and the carrier's and the commission's book record of investment in road and equipment. Further than this, many are interested in the cost of reproduction and the cost of reproduction less depreciation of the property owned and used and of that owned but not used for transportation purposes.

By summarizing this and other basic data which would involve little additional work the commission would protect its report from misuse and misinterpretation, and would complete the service to the public for which the Division of Valuation was created. The commission owes it to itself, as well as the public, to complete its report in this way to protect itself against the misuse of its information and to enable the public, regulatory bodies, the railways and investors to avoid all possibility of confusion as to results. The commission will render a great service to the railways and to those interested in them by presenting such a summary in order that he who runs may read.—Editorial in Railway Age.

A Record in Rail Production

Production of rails 100 lb. and over per yard in 1921 was the greatest in the history of the rail industry, the output being 849,566 tons, the heaviest production of such sections previously having been 766,851 tons, in 1916. It has been more or less customary for many years past to speak of there being a "controversy" between the rail producers and the railroads, but the word is not altogether fitting. There has been a difference of aim. The railroads wanted a higher quality of rail, with little extra cost over the base price, while the rail mills favored the using of heavier sections. It would appear from the statistics of production that the rail mills have been making progress in having their contention put into practice, for the ratio of rails 100 lb. and over to rails 85 lb. and over but under 100 lb. has been steadily increasing. The 1921 production was as follows, in gross tons:

Under 50 lb.	211,568
50 to 84 lb.	214,936
85 to 99 lb.	902,748
100 lb. and over	849,566
Total	2,178,818

The total production of rails in 1921 was small. Since 1898 there have been only 2 years, 1908 and 1914, with lighter production. The record high production was made in 1906, with 3,977,887 tons. Statistics of rail production, of course, furnish no key to the manner in which track is being maintained. In 1887 and nearby years there was much building of new railroad, with heavy rail production, as well as imports. In 1906 and nearby years there was much laying of secondary track, together with particularly great replacement because old and light section rails were being destroyed rapidly by the heavier rolling stock recently introduced.

Even at the present time there is some rail wear, necessitating replacement, that will proceed more slowly in future, through rails being replaced by heavier sections. If the rails ever catch up with the rolling stock, by improvement in quality and increase in section, annual replacement requirements of the railroads will represent a relatively unimportant portion of the total steel output of the country. It is recognized, of course, that as the section is increased the tonnage required to lay a given length of track is correspondingly increased.

The industrial use of rails has been increasing steadily with the growth of industrial operations, or even more rapidly. In 1913 the production of rails 45 lb. and lighter was 470,405 tons, whereas in 1920 the production was 489,043 tons, an 81 per cent increase, while for 1921 production, naturally enough, dropped to 211,568 tons. The proportion of light or industrial rails to rails required by the regular steam roads has greatly increased.

The bessemer rail has practically disappeared. In 1907 production was 13 tons bessemer to 1 ton open-hearth. In 1911 open-hearth passed bessemer. In 1921 there was 36 tons of open-hearth to 1 ton of bessemer. In 1912-13 a total of about 6,000 tons of electric rails was produced, for experimental purposes, while there had been practically no such production since then. The alloy-treated rails, which ran about 150,000 tons in both 1911 and 1912, have almost disappeared. Doubtless there is a connection between these facts and the increased vogue of rails 100 lb. and over in section.—Editorial in Chemical and Metallurgical Engineering.

Contracts Let for Pennsylvania R. R. Line Into Detroit

For a number of years the Pennsylvania R. R. has been planning to build its own line into Detroit, Mich., from Toledo, O. This project is now nearing the construction stage, the contract for grading for twenty miles of line from Carleton to a junction with the Wabash R. R. in the village of Oakwood, was let a few days ago. This line will be double track, and one track will be laid this summer.

The total cost of the project will be between $15,000,000 and $20,000,000. It is planned to expend $3,500,000 this year in construction. The entire project includes the construction of storage yards in Ecorse township to accommodate 12,000 freight cars; the construction of a new belt line around Detroit; the erection of a new passenger terminal in conjunction with the Pere Marquette and Wabash railroad, and the building of several small yards in Detroit.

Construction Volume Doubles

The following weekly summary was written by the editor of Engineering and Contracting for the Chicago Journal of Commerce:

Construction statistics for the first five months of 1922 are now available and show some interesting facts when compared with the corresponding five months of 1920 and 1921. Expressed in millions of dollars, the total contracts awarded in the three corresponding five-month periods were:

First 5 Months.	1920	1921	1922
Public Work	[illegible]	$ 285	$ 347
Buildings	[illegible]	974	1,685
Total	[illegible]	$1,259	$2,032

Taking construction prices as 100 per cent in the year 1913, the corresponding percentages for the first five-month periods of 1920 to 1922, were 250, 220 and 175. In other words, construction prices for the first five months of 1922 averaged 30 per cent lower than for the corresponding period of 1920 and 75 per cent higher than for the year 1913. Hence the volume of construction for the first five months of 1922, measured in materials and days labor and not in dollars, exceeds that for the corresponding period of 1920 by 33 per cent, and exceeds that of 1921 by 100 per cent.

No reliable statistics are available for railway and public utility company construction during the same period; but this class of construction is languishing for lack of capital. The recent rate decision of the Interstate Commerce Commission, in which 5¾ per cent was declared to be a "fair return" on railway capital, is typical of the shortsightedness of most rate-regulatory commissions. When capital can be invested in so many other ways, with less risk and with the probability of earning considerably more than 6 per cent, few investors care to put money into railway stock to be used for new construction and betterments.

There has been not a little criticism of the government's policy of exempting municipal and state bonds from income taxation. It has been argued that such exemption is attracting an undue volume of capital into public works construction. However, a study of statistics shows that public works construction is not holding its own with building construction. The above table indicates that public works contracts totaled only 17 per cent of all contracts thus far this year, as compared with 20 per cent in 1920 and 22 per cent in 1921.

There is not a particle of statistical evidence to show that cities, counties or states are growing extravagant because of their bonds being tax exempt. Public works construction, it is true, is somewhat above the prewar volume, but it should be remembered that it was subnormal for the four years of 1916 to 1919 inclusive.

The Railroad Wage Decision

The wage decision announced May 29 by the Railroad Labor Board, signed by the three railroad members and the three public members of the board, states that the new wages will be higher than in other industries for similar work, a margin having been allowed to cover the hazards of employment and other considerations. The dissenting opinion, of the three labor representatives on the board, says that the wages decreed are insufficient to sustain life on the basis of American standards.

Here is a big issue and at the same time a very simple one. It cannot be claimed that the wage rates prescribed are relatively low, for the board had ample basis of fact to warrant the statement that railroad wages will be higher than other wages. The contention of the minority, then, is in essence that all wages in the United States are too low to sustain life on the basis of "American standards."

Now the use for wages is to spend them for commodities and services. The commodities and services must be available or they cannot be bought. Imagine a small island inhabited by a single native possessed of a certain amount of food. Two men are shipwrecked on the island, each with $1,000 in his pocket, and the native is quite willing to sell all the food he has. Each of the shipwrecked men, other things being equal, will get half. If before they started to bargain you had given each man $1,000 more money they would not have got any more food. There would simply be $4,000 passed over instead of $2,000. The food would not be Americanized by that means.

Estimates of the national income of the United States made respectively by counting up individual incomes and by counting up the value of the production substantially agree. The income buys what is offered for sale. If we want more we must produce more. We cannot increase the quantity of material and the amount of service by bidding more dollars.

To carry on industry at all in these days the workers must have tools and direction. The railroad workers could accomplish nothing without cars, locomotives and track, or without managers to direct their work. These things, tools and management, have to be paid for. Approximately speaking, between 20 and 30 per cent of the total national income goes for these purposes, workers for wages and salaries getting the other 70 or 80 per cent. And there is strong reason for holding that the workers are better off when the share for tools and management is 30 per cent than when it is 20 per cent.

There is, then, only one way to bring about a higher standard of living generally, and that is to increase production, by men working harder and more efficiently and with better tools.—Editorial in Chemical & Metallurgical Engineering.

American Association of Engineers Annual Convention and Election of Officers

The eighth annual convention of the Association was held in Salt Lake City on June 5, 6 and 7. The following were the important discussions and actions of the meeting:

The reclamation of arid and swamp lands was endorsed and also the Smith-McNary Bill now pending before Congress.

The appointment of an engineer executive on the U. S. Civil Service Commission was urged; and A. B. McDaniel recommended for appointment.

Prompt action by Congress on the bill to aid federal employes (H. R. 8928) was recommended.

An official statement of the policies of the Association to railroad executives was authorized to acquaint them "with the real objects of the A. A. E.: the betterment of the conditions of the engineer, the education of the public as to the dignity and importance to civilization of the profession of engineering, and that the best interests of the profession, as such, call for loyalty to, co-operation with, and devotion to the interests of the client or employer, whether corporate or individual."

Action by Congress to relieve the labor shortage in Hawaii was urged and support of Joint Resolution 171 H. D. recommended.

Service to special classes of engineers was recognized and urged by the Association as a whole rather than by action as classes.

Close co-operation with business clubs was urged and provided.

Provision was made for support of work or local units by granting them 40 or 60 per cent of the annual dues, depending on the amount of work undertaken by the local units.

A. N. Johnson, Dean of Engineering, University of Maryland, and George E. Taylor, Consulting Engineer, Charleston, W. Va., were elected respectively president and first vice-president of the ensuing year.

Civil Service Examination

The U. S. Civil Service Commission announces examinations for the position of Junior Engineer and Deck Officer in the Coast and Geodetic Survey; the examinations to be given Aug. 9 and 10 and Oct. 4 and 5, at numerous places throughout the country. The entrance salary is $2,000 per year. Examination subjects are as follows:

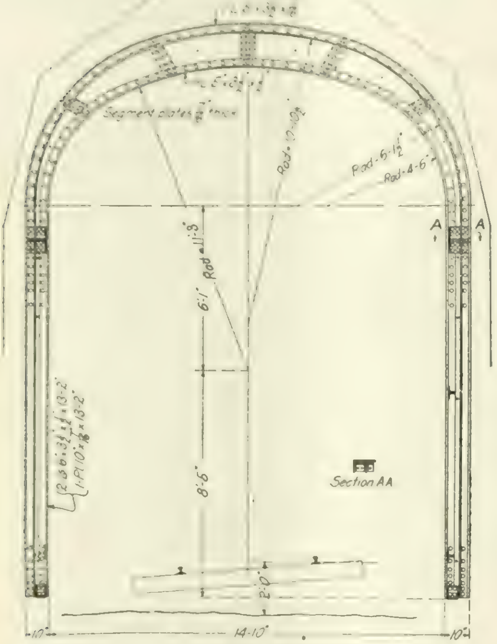
	Weights.
1. Mathematics (including trigonometry, analytics, mechanics and calculus)	15
2. Practical computations (involving the use of logarithm tables)	20
3. Modern languages (competitors may select one of the following: French, German, Spanish; extracts of about 125 words are given for translation into English)	10
4. Astronomy (questions in spherical and general astronomy with especial reference to determination of latitude, longitude, time and azimuth, and use of field instruments)	20
5. Physics (questions in optics, magnetism, etc.)	15
6. Surveying (questions in plane and geodetic surveying and on the use of field instruments)	20
Total	100

More complete information will be furnished upon request by the Civil Service Commission at Washington, D. C

Method of Widening Five Tunnels on Virginia Ry. for Double Track

The recently completed double tracking of the Virginian Ry. between Elmore, W. Va., and Clark's Gap, a distance of about 13½ miles, required the widening of five tunnels. This last mentioned work involved a number of interesting features, chief of which was the use of a steel shield in the driving of the tunnel headings for the second track. We are indebted to the Railway Age for the following details.

The five tunnels varied in length from [illegible] ft. to 1,252 ft. and were all through rock which is mostly shale or hard sandstone stratified and often underlaid or intermixed with slate and coal seams. It was of course essential to maintain uninterrupted traffic and as the rock required blasting it then became necessary to provide some form of shield to prevent rock, old lining or miscellaneous construction and other materials from falling down or working out on the line. To meet this requirement a sectional shield was developed which could be set up inside the old tunnel without any changes in or disturbance to the old lining and which could be moved ahead quickly as the work progressed. Each section of the shield consisted of two arched ribs fastened 4 ft. apart and supported by light steel posts. Each arch rib was built up by riveting steel plates, cut to shape, to steel angle bars bent to the desired radii as shown in the drawing. The total inside width was 14 ft. 10 in. and the maximum overhead clearance was about 18 ft. 2 in. from top of rail. The lagging, consisting of 4-in. by 8-in. planking cut into 4 ft. lengths was bolted to the ribs, thus making unit sections 4 ft. long and completely enclosed over the top and sides.



The Frame for the Steel Tunnel Shield.

The old tunnels, which were timber lined, had a clear width inside of 18 ft. and an overhead clearance of 21 ft. 6 in. from top of rail, while the double track tunnel gives a clear width on curves of 32 ft. and on tangents of 30 ft. 6 in. and an overhead clearance of about 24 ft. from the top of rail. The design was that of a three-centered arch of reinforced concrete with a minimum thickness of 2 ft. 2 in., backed up with the usual timber lining consisting of 12-in. by 12-in. posts supporting 12-in. by 12-in. ribs and completely enclosed by 3-in. lagging on the sides and 4-in. over the top. Thus in order to obtain the necessary clearance from the center line of the existing track it was necessary to excavate about 2 ft. of the side wall of the tunnel beyond the limit of its old lining on one side while the remainder of the necessary width for double track was secured by excavation on the opposite side of the center line.

In carrying out the actual work of widening a tunnel, 15 of these steel sections were erected by the aid of a hand derrick mounted on a flat car, inside the regular lining of the old bore. This gave a length of 60 ft. over which the work could be carried on with complete protection to the operating track beneath. With the protective shield in place, the driving of a heading of the necessary double track width was started. On this work the heading was driven through for the entire length of the tunnel before any work was started on the removal of the bench. This plan was followed in order that the excavated material could be hauled out in the most economical way. The work of removing the 2 ft. section on one side, the section over the top of the old arch and approximately 18 ft. on the second track side was carried on simultaneously.

Air drills were used for this work, the lighter or hand-type being employed in preference to the tripod type. From four to six were in operation on each heading. As the rock was very hard in most cases, the material was blasted out, after which it was loaded into narrow-gage dump cars which were operated over a track laid along the bench as excavated. A platform was constructed at the portal on which the cars could be run and their contents were trapped into standard-gage cars. On an average about 22½ cu. yd. of material was removed per lineal foot of tunnel. Of this about 13 cu yd. was from the heading, including the small section on one side and 9½ cu. yd. from the bench. Progress at times was exceedingly slow, long stretches being excavated at a rate of not over 1 lin. ft. per day.

As the removal of the heading was accomplished, the new timbering was erected and one or more sections of the shield moved ahead, the face of the heading being kept approximately three sections behind the forward end of the shield. With the heading driven through, the bench was broken or shaken up by blasting where needed and the material removed with a steam shovel which unloaded it into air dump cars operating on the main line between regular trains. The cuts along the line were widened by blasting where necessary and the material removed with steam shovels and standard-gage dump cars. All the material excavated from the cuts and tunnels, amounting to about 250,000 cu. yd., was used in widening fills for the double track.

The compressed air to operate the various tools as well as the necessary current for the lighting equipment used in the tunnel work and at the camps was furnished by two separate compressor and electric lighting installations. Air was supplied through a 4-in. main from each of these plant installations, the maximum length of pipe being approximately 1¼ miles.

The work of double tracking was planned by and the construction has been carried out under the direction of the engineering department of the Virginian Ry., H. Fernstrom, chief engineer; A. M. Traugott, assistant chief engineer, and J. C. Guion, resident engineer in direct charge of the work in the field. The contractors on this work were J. V. Boxley & Co. and Boxley, Goodwin & Bray, subsidiary companies of W. W. Boxley & Co., Roanoke, Va., to whom the original contract was let.

Burning Weeds Along Railway Right of Way.—The Texas & Pacific R. R., according to Popular Mechanics, is using a weed-burning outfit which will clear 5 miles of track per hour. Upon a 60-ft. specially built car is a unit of two heating retorts, one of which is a 180-cu. ft. capacity furnace wherein combustion between air and gas is completed at a temperature of between 2,500 and 3,000°. A second mixing chamber which is the same in style, but considerably larger and in which the temperature is reduced to about 1,400 to 1,500°, works subsequently and in conjunction with the first. The heat is forced from here to a 38-ft. hood which straddles the rails under the car and spreads to a distance of 10 ft. outward from the center of the railway. Steam turbines are used to drive the blowing fans which furnish the combustion chambers with air. Safety dampers are also provided by which the torrid discharge may be checked in passing over bridges, walks, etc. Three men, an oil and water supply, and an oil-burning engine are required for operation of the unit.

Adjusting Track Construction to a Light Weight Street Car

An interesting description of two track jobs completed recently in Fort Worth, Tex., in which advantage was taken of the light weight of the Birney cars operated there to cheapen construction was given by R. G. Taber, of his Division of Construction and Engineering of Stone & Webster, in a paper presented last month before the Street and Interurban Railway Section of the Southwestern Electrical and Gas Association. The following abstract of the paper and illustration are taken from the Electric Railway Journal:

Since 1906, when the writer first became associated with Stone & Webster, track construction for permanently paved streets has undergone radical changes. There still exists considerable difference of opinion as to what constitutes the best type of construction for paved streets, but all agree that what we are striving for is to find that type of track construction of first low cost which gives a long life with an economical maintenance cost.

The most successful type with which the writer has had experience is what may be termed the "sandwich" type. This involves a sub-base of concrete, gravel ballast, the track itself, the paving base and the surface. The sub-base assures uniform resistance of the substructure. The gravel ballast transmits the load from the ties and its flexibility allows the track to be brought to a true surface. It also allows immediate operation of cars on completion of the job. Furthermore, it provides resilience. The ties take the load from the rail, distributing it through the ballast, while the rails furnish the requisite stiffness for the structure, especially after the paving base has been poured.

A radical change, which should have due consideration in the designing of track, is that which is due to the modern lightweight equipment. It is inconsistent to build track for the 15,000-lb. Birney cars as heavy as that which is necessary for double-truck 44,000-lb. cars. Although modern equipment is less than half the weight of old designs, this does not mean that the track weight can be reduced proportionately. It does mean, however, that there is another factor to be considered in the design of street railway track construction.

Working along the line of lighter construction of track for use with lighter cars, the writer first attacked the matter of tie spacing. The standard spacing is 2 ft., but on two track jobs just completed in Fort Worth the ties are placed on 28-in. centers.

On these tracks, on which Birney cars are operated, there is a 6-in. concrete sub-base, with 4 in. of ballast under the ties. Tie plates are used on every tie, and other details include screw spikes, 7-in. 70-lb. tee-rail, brick headers next to the rail on the inside of the track, a 6-in. concrete paving base and a 2-in. bitulithic wearing surface. The total length of the two jobs is somewhat over a mile.

The saving on these jobs was 378 ties, which at the rate of $1.77 saved $650 or 13½ per cent in the tie account. While this amount may seem small, in a city paving an 80-mile street railway system the saving alone on ties at this rate would amount to $2,600 per year, assuming a life of 20 years for a tie. The saving would apply under current conditions as to prices if the plates and spikes are included.

The tie is only one item. The writer firmly believes that if engineers will pull together they can make large savings in other directions. Take, for example, the rails: in place of the special rolled sections which have been considered necessary in the past, with lighter equipment it ought to be possible to find a standard section that will meet the requirements.

The next important step after agreement has been reached as to the best type of construction for either heavy traffic or light traffic is provision for proper supervision. This is a matter which usually does not have sufficient attention.

Referring to the illustrations of track cross-sections used at Fort Worth, Fig. 1 is the construction now being used for the track for the lightweight Birney car. Fig. 2 shows the type being used in the downtown section for heavy traffic where double-truck and interurban cars operate. While concrete sub-base is used in both cases, the writer does not believe that this is necessary where the soil and other natural conditions provide suitable drainage.

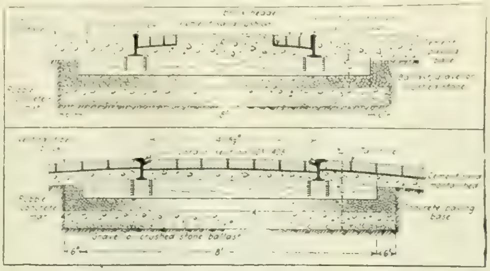


Fig. 1, Above—Track Used in Fort Worth for Safety Car Traffic Only (See Table I). Fig. 2, Below—Fort Worth Track for Congested Downtown Streets (See Table II).

Street Railways Use Pitch in Repairing Brick Pavements.—In answer to a query in A. E. R. A. regarding the use of paving pitch instead of cement grout in repairing brick pavements, six street railway companies, all that replied, stated that they used pitch as a filler. E. H. Berry, Engineer of Roadways of the Cincinnati, O., Traction Co., reported that "much better results have been secured with paving pitch. By using pebbles with the pitch and filling all voids with the latter, water does not penetrate to base to any extent. It is much easier and more economical to make repairs when pitch is used. Cement grout here has not been at all satisfactory, except first cost saving." P. S. Duenweg, Engineer Maintenance of Way, Houston (Tex.) Electric Co., stated that "for all paving repairs, such as joint work or where we are repairing small patches of brick pavement, we use paving pitch instead of cement grout. With the paving pitch traffic can be allowed over the pavement as soon as the same cools, while with grout, in order to obtain satisfactory results, traffic must be kept off for several days. We have obtained very good results from the use of paving pitch for repairs."

TABLE I.—DATA FOR TRACK AS IN FIG. 1.

Material for 1 mile of track—				
Item.	Kind.	Size.	Quantity.	Remarks.
Rail	High-tee	70-lbs	110 tons	
Joints	Simplex bars	70-lbs	180 pairs	
Bolts	Machine	⅝-in. x 3½-in.	360	
Tie plates	Sellars	6-in. x 9-in. x ½-in.	5,300	4,524 with ties on 28-in. centers
Spikes	Screw	⅝-in. x 6-in.	11,000	9,050 with ties on 28-in. centers
Ties	Pine	6-in. x 8-in. x 8-ft.	2,650	2,262 with ties on 28-in. centers
Ballast	Gravel	¼-in. to 2-in.	1,250 cu. yd.	
Pavement	Bitulithic	2-in. thick	5,520 sq. yd.	
Brick headers	Vertical fiber	3-in. x 4-in. x 8-in.	47,000	
Concrete	Paving base		850 cu. yd.	
Concrete	Mat		880 cu. yd.	

TABLE II.—DATA FOR TRACK AS IN FIG. 2.

Material for 1 mile of track—				
Item.	Kind.	Size.	Quantity.	Remarks.
Rail	Groove	103-lb.	162 tons	
Joints	Apex bars	103-lb.	180 pairs	
Bolts	Machine	1 x 3-in.	360	
Tie plates	Sellars	½ x 7-in. x 10-in.	5,300	
Spikes	Screw	⅝-in. x 6-in.	11,000	
Ties	Pine	6-in. x 8-in. x 8-ft.	2,262	
Ballast	Gravel	¼-in. to 2-in.	1,250 cu. yd.	
Pavement	Brick	3-in. x 4-in. x 8-in.	80,000	
Filler	Tar		70 cu. yd.	
Mortar bed	Cement sand		65,000 lb.	
Concrete	Paving base		850 cu. yd.	
Concrete	Mat		880 cu. yd.	

Cost of Treating Ties Should Not Be Charged to Maintenance

In our issue of March 15, we printed a paper presented before the American Wood Preservers' Association by Mr Earl Stimson, Chief Engineer Maintenance, Baltimore & Ohio R. R. In his paper Mr Stimson gave his views regarding changing the cost of treating ties to maintenance. A reply to Mr. Stimson's paper by Mr. F. S Schwinn, Chief Engineer International & Great Northern Ry., appeared in the Railway Review, from which we reprint the matter that follows:

The railway maintenance engineer can no longer limit his horizon in considering the repairs and renewals necessary for the property in his charge, but must include in his consideration the viewpoints of the financier, the executive and the accountant. This requirement has been growing more imperative during the past 10 or 15 years, a period of rapidly increasing railway regulation by governmental bodies, which has been brought to a fitting climax by the passage of the Transportation Act of 1920. Railroads cannot be constructed or operated as institutions for the public benefit only; they must earn a fair return upon their value if they are expected to continue in existence and keep abreast of the development and progress of the territory which they serve.

The primary need of a railroad is to earn money for operating expenses, fixed charges, improvements and, in order that it may prosper and fulfill its obligations to the investors in its securities, sufficient to pay a reasonable rate of return on those securities. The lack of sufficient earning for all of these requirements is first felt by the maintenance departments, and falls heaviest upon the maintenance engineer. Still, some of those most vitally interested continue to advocate the charging into operating expenses of amounts representing improvements to their property, and go so far as to argue in favor of the most glaring inconsistency in the present accounting rules—that requiring the charging of the cost of treating ties to maintenance.

If it is true that the Classification of Investment in Road and Equipment, Issue of 1914, as prescribed by the Interstate Commerce Commission, does not permit a charge to investment covering the cost of treating a tie used to replace an untreated tie, although it and the Classification of Operating Revenues and Operating Expenses, Issue of 1914, are both notably lacking as to specific instructions on this point. Betterments are defined in the Classification as improvements of existing facilities through the substitution of steel-tired wheels for cast wheels under equipment, the application of heavier rail in tracks, and the strengthening of bridges by the substitution of heavier members. We are led to infer that the excess cost of metal ties applied in the place of wooden ties over the current price of the wooden ties removed is the only betterment that can be obtained in a tie system. Are we to believe that a treated tie is no better than an untreated tie? If this could be a fact, then why do we use them?

Treated Ties Superior to Untreated.—The real facts have proven treated ties superior in overcoming decay to untreated ties. Their use results in economies of operation equally as important and probably even greater than the economies secured from the application of heavier rails, ballasting of tracks, reductions of grades, or the development of terminal facilities. Improvements of the nature just mentioned are made with the intent of reducing operating expenses. The treatment of ties ordinarily will double their life, and in that way will also reduce operating expenses. Can it be possible that this is not an improvement, or a betterment of the property under a proper definition of the word?

The carriers have, during the past 8 years, been undergoing a valuation by the valuation bureau of the Interstate Commerce Commission. This bureau has not valued the untreated tie as highly as the treated tie because it recognizes the difference in worth. There would have come very strenuous objection from the carriers if the bureau had done otherwise. Now the Interstate Commerce Commission is attempting to perpetuate this valuation by its Valuation Order No. 3, Second Revised Issue. But under this order, a carrier which may have used in renewals 1,000,000 treated ties replacing untreated, since its valuation date, at an increased cost over the cost to replace in kind varying from 25ct. to probably as high as 75ct. per tie, and conservatively averaging 50ct. per tie, or $500,000 total increased cost, cannot capitalize this $500,000 improvement, but must charge the value of the improvement to its operating accounts. Will such handling perpetuate the valuation work now almost completed? Is it not unfair when this carrier is deprived of its increased value, to give another carrier, constructed new in the past two or three years with, say, 1,000,000 treated ties in track, the privilege of capitalizing the full cost of those ties and earning a higher net operating income based on this higher capitalization?

Increased Value of Tie System.—Under the Transportation Act of 1920 the Commission has placed a value upon the carriers by groups and fixed rates designed to earn a fair return upon such value in the aggregate. Two years have passed and at no time have the rates been sufficient to allow even a fair-sized minority of the carriers to earn this promised return upon their value. But, assuming that conditions had been normal during this period, and that the carriers as a whole had earned the maximum allowable return, then this return would have been short by the amount they should have earned on the increased value of their tie systems, resulting from the betterment growing out of the practice of using treated ties in larger numbers each year. And likewise the operating expenses would have been, and actually were, greater than they properly should have been to the extent that they included the increased values of the improved tie systems.

Should not the Commission amend the present accounting rules as affecting treated ties? By so doing it would not only allow the carriers to earn a larger net operating income, but would materially decrease the operating expenses of the carrier, which decrease would finally reflect itself in lowered rates. It has been suggested that it would not be practical to keep accurate account of treated ties. This can be done very simply by the use of a marker so that treated and untreated ties can be identified and classified when retired.

It is quite true that there are varying kinds of treatment, both as to cost and effectiveness. But this cannot be used as an argument against charging the increased cost due to treatment to capital account. The cost of the same kind and size of untreated ties varies in different portions of the country. The valuation bureau did not argue that a flat price should be used for each size and kind of tie regardless of the local conditions entering into its cost. Neither can the increasing ratio of the cost of the timber to the cost of treatment have any bearing upon the principle involved. The treated tie will always cost more than the untreated, and the excess cost due to treatment will always be an appreciable amount.

All Ties Will Have to Be Treated.—The more general treatment of hardwood, as well as softwood ties, is being strongly advocated, and it will not be many years in the future when practically all ties will have to be treated as an economic necessity. It has been the urge of this necessity which has caused carriers in the past to attempt, through treatment, to increase the tie life, by from 75 to 100 per cent, regardless of how the cost was accounted for. But, can they be expected to continue this practice with the accounting classification throwing the expense into operating accounts and the Transportation Act limiting their income? Railroad earnings are now low ana have been for so long a time that the carriers must have forgotten the meaning of prosperity, although the rates are now generally higher than at any time prior to 1920, or tnan they probably ever will be in the future. Then what better method of providing for the increased expense due to treatment of ties can be found than by capitalizing this increased cost?"

The writer is an unqualified advocate of the use of treated ties and would regret being interpreted otherwise. But it is not merely desirable, but very essential to the continued use of treated ties in annually increasing quantities, that the excess cost be properly accounted for as a betterment, and that inconsistencies in the Classification of Investment in Road and Equipment be removed. The maintenance engineer cannot keep every dollar of the carrier's earnings for maintenance uses only, but must share them with other interests who, by virtue of their investment, have a right to a share. He must plan his expenditures in such a way as to make the earning of each succeeding dollar just a little bit easier than the one before, and in so doing he will not be paying tribute to capitalization but will merely be fulfilling his trust

Shoveling Machines and Their Operating Costs

Equipment Designed for Restricted Spaces in Mines May Find Application in Railway and Other Tunnel Construction

What follows is a slight condensation from an article in the Coal Age of May 18, 1922:

The shovel is never any better than the management behind it enables it to be. If cars are not supplied in a steady stream it cannot hope to give a good account of itself. The efficient work of shovels in strip pits, where car deliveries are easily arranged, gives an inkling as to the possibilities below ground if cars could only be furnished with equal regularity.

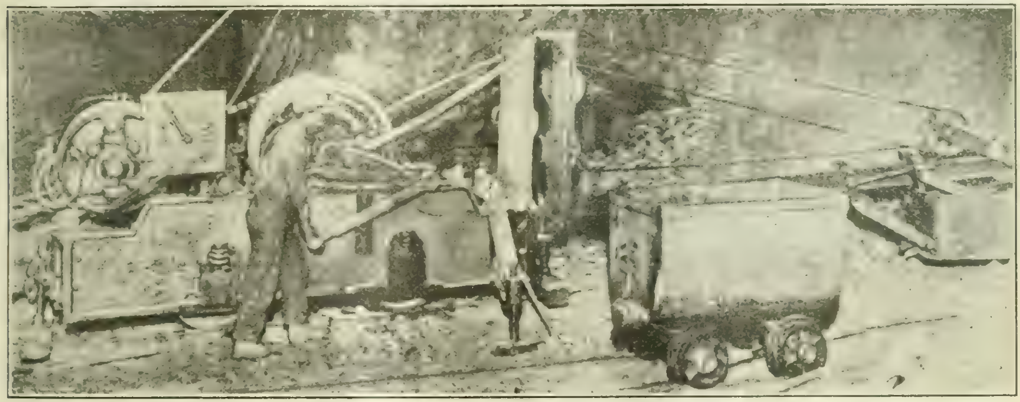
The Bureau of Mines recently published a bulletin by C. Lorimer Colburn on the work of underground shovels in metal mines, entitled "Underground Loading Devices in Metal Mines," Serial 2,300 of "Reports of Investigations." The unbreakableness and size of the material shoveled in metal mines militates against favorable results. So also does the narrowness of the drifts and the smallness of the cars. In metal mines, with some exceptions, the roof is bad, much timbering is necessary, and conditions such as obtain in salt mines, where large roof spaces are permissible, cannot be found. However, in some mines working in chert or limestone the roof is unusually strong and will stand over large areas the like of which no coal mine could possibly leave unsupported. Props are not used in these mines, and in some few cases immense areas have been left entirely without interior pillars. The Bureau's results, however, are not all for shoveling under any such favorable conditions.

The Hunt Rotary Shovel.—This machine, which has revolving buckets the movement of which is regulated by carefully designed cams and which feeds to a conveyor belt, has all the advantages of the continuity that comes from such a design and it also has the quality of being kindly to the coal intrusted to its care. It is quite capable of handling lumpy material without breakage, as the buckets are large enough to tackle big lumps exceeding those that a man can lift. The Bulletin declares that "the management [at the Mayville Iron Mines of the Steel & Tube Co of America] states that the machine has loaded as many as 116 cars of three-ton capacity in eight hours." That is about 348 tons in a day, or 43½ tons per hour. The report adds that "no records of this machine over a long period of time are available."

The Myers-Whaley Machine.—In one mine visited by Mr. Colburn a Myers-Whaley shovel was installed. It had been in use three years. The management stated that during 1918 more than 30,000 tons of material was shoveled at a cost of 20.07c a ton. This cost was divided between repairs (9c per ton) and operating labor and supplies (11.07c). During 1919 nearly 39,000 tons was shoveled at a cost of 19.15c per ton, and during 1920 nearly 40,000 tons at a cost of 20.69c per ton.

The tonnage on individual machines varied according to the thickness of the ore body, the amount of ore available and the time required for switching cars. The average was about 100 tons per eight-hour shift but when it was possible to work five or six hours in one or two headings, 130 to 150 tons was loaded. The crew consisted of one operator and one mule driver. The operator would break up boulders while the driver was switching cars.

In another mine a test was made which was observed by a Bureau of Mines Engineer. The machine had one runner, two helpers and a shoveler in attendance. A locomotive was kept constantly at hand for switching purposes. The machine readily shoveled the four and one-half tons necessary to fill the car in three minutes, after which ten minutes was taken to switch the loaded car about 500 ft. and to replace it with an empty. Over a period of two hours this machine handled cars at the rate of one car for every fifteen minutes, or eighteen tons per hour. A shift's work was about 125 tons.


Conway Shovel Loader in Which the Dipper Slides Back and Forth Along a Boom.

In another mine the Myers-Whaley machine was used to handle material in a slope. The machine in this mine was compelled to work on a grade of from 5 to 10 per cent. It worked nicely on a 5 per cent grade and with difficulty on one of 10 per cent. The working face was 10 ft. high. During the period that observation was made the machine shoveled 2,653 tons, which was at the rate of 12 tons per hour. The costs were as follows: Shoveling, 20.80c; drilling, 8.71c; blasting, 15.39c; total, 44.9c per ton. The cost of doing the same work by hand was 58.5c per ton.

In July, 1918, Witherbee, Sherman & Co. purchased for its Harmony mine one No. 4 type Myers-Whaley shoveling machine. In 1920 three additional machines were installed. The material handled was magnetic iron ore. The wage paid the shovel runner was 57½c per hour, and that of the helpers 47½c per hour. Five men ran the machine and handled the cars. The average tramming distance was 250 ft. Table I gives information about these costs.

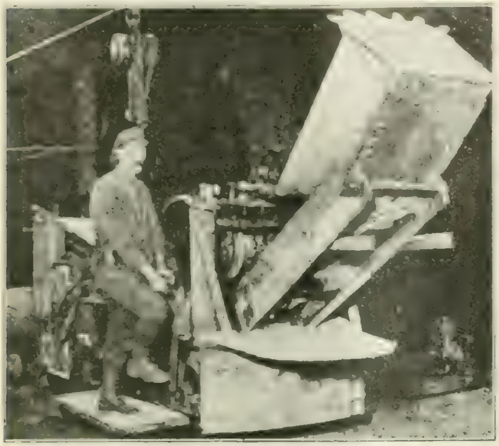
The Conweigh Digger Belt Loader.—In this machine the shovel lifts the load which when released slides out of the

TABLE I.—OPERATING COSTS FOR 1920 AT THE HARMONY MINE.

	—During 7 months—			During 12 months.
Tonnage	12,459	10,565	9,996	12,387
	Cts	Cts	Cts	Cts
Operating labor cost	12.7	14.8	14.8	19.1
Repairs, labor cost	3.1	5.4	3.0	15.0
Repairs, supply cost	8.7	10.1	9.6	28.0
Shops and miscellaneous	0.4	0.1	0.1	3.8
Power	0.4	0.4	0.4	0.4
	25.2	30.8	27.9	66.3

The higher costs for the last machine are mostly in repairs. This machine was bought in 1918 and was practically rebuilt except for motor and frame [illegible] backward onto a belt conveyor. The dipper can be swung [illegible] in a vertical plane. A [illegible] motor provides the power. Standing on a platform at the side the operative can readily see and direct the digging operations.

The machine has been in operation in the mines of the National Lead Co., St. Francois, Mo. The record for the month of February, 1921, was an average of [illegible] tons of ore loaded in an eight-hour shift with one operator and one helper. [illegible] tons was loaded during the month. These two men not only load the cars but push the empty one-ton capacity cars to the machine and deliver the loaded cars to the motor haulage loop. A labor cost of [illegible] per ton was reported for the February operation. To this should be added the cost of power and repairs. The [illegible] expects to reduce its present loading costs of 16.64c per ton by using this machine.



Conway Digger Belt Loader.

The dipper is hinged to the dipper arm and can be swung on [illegible] in a vertical plane. Both front and back of the dipper are open. The dipper arm is so constructed that it forms a [illegible] through which the material slides from the dipper to the belt conveyor.

Locust Mountain Coal Co. Machine. In some ways the Conweigh shovel loader closely resembles the machine devised for the Locust Mountain Coal Co. by Mr. Brown and described in Coal Age March 3, 1921. It consists of a boom mounted on the forward end of a steel frame. A dipper slides back and forth on the boom, which can be swung to either side or up and down.

The machine is controlled by an operative who stands to the right of the machine. The movement of the dipper and boom is controlled by two levers. The dipper is pulled into the pile of material and after filling itself is raised over a car which may be placed on a track laid on either side of the machine as desired. As soon as the dipper is over the car the operative pulls a rope and the bottom is tripped, releasing the load.

During 1920, at the St. Louis Smelting & Refining Works of the National Lead Co., St. Francois, Mo., 169,751 tons of ore was loaded by seven of these machines, which made an average of 62.4 tons loaded per shift. The average was 16.64c per ton. The costs were distributed as follows: Operating labor, 11.9c; repair labor, [illegible]; supplies, [illegible]; power, [illegible]; total, 16.64c per ton.

The Shuveloder. The Shuveloder has been in use in coal mines for some time. One man operates the machine and another switches the cars. In some places where digging is quite difficult a third man is used as a helper. At one mine the loader was used intermittently. Working on rock it [illegible] 125½ cars of 2½ tons capacity in 22½ hours, or 5.7 tons per hour, at a cost of 25.9c per ton. Time included tramming the cars 175 ft. The actual time of loading was 16½ hours. The delays were due to tramming, switching, derailment of loader and repairs. In another test, working on [illegible] cars were loaded in [illegible] hours at a loading cost of [illegible] per ton. The actual loading time was 2½ hours.

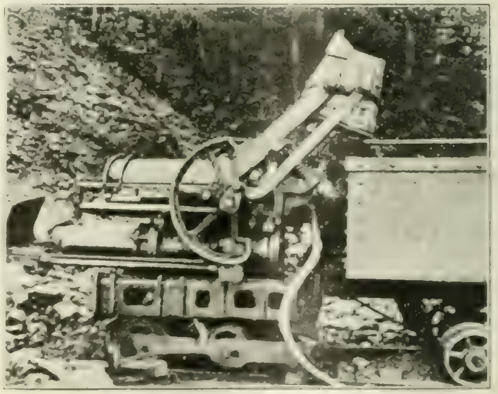
The Armstrong Loader.—An Armstrong No. 11 shovel was in use at the Colby mine of the McKinney Steel Co., Bessemer, Mich., to load broken rock in driving drifts. The drifts are 7 ft. high by 8 ft. wide, and the pile of rock is about 19 ft. long and about 4 ft. high at its deepest place. There are about 14 carloads of 32 cu. ft. capacity to the pile. Two men were used in loading—one operative and one attendant who switched the cars. The machine was observed during the shoveling of one of these piles of material, with the following results:

Total time of setting up machine, 10 minutes; time of loading 14 cars, 58 minutes; 12 move-ups of loader, 30 minutes; switching 12 cars, 92 minutes; total, 190 minutes. Total number of cars loaded, 14; total cubic feet, 448; total number of move-ups, 12; total number of loader dippers, 222. Average number of loader dippers to a car, 16; average number of loader passes per minute, 4; average time for loading cars, including move-ups, 6 minutes; average time for loading one ton of rock, including move-ups, 2.4 minutes. Total time required for setting up the Armstrong shovel, loading and tramming of the rock, broken from an average break of a round of holes took one hour and 45 minutes.

The Thew Shovel. The Thew shovel when it first entered the coal mines was a top-heavy machine that could be used only in mines like that at Hanna, Wyo., where the deposit was more than 30 ft. thick. It has been redesigned, as the illustration shows. The capacity is about ⅝ cu. yd. The boom is rigid, being built up of steel so as to require the minimum headroom. The operating mechanism consists of a 20-hp. motor and the necessary gears and other mechanical parts to operate the machine. The operating mechanism is mounted on a platform. Below the platform is a turntable which revolves the entire shovel through a full circle of 360 deg. The entire machine is carried on the truck, which is on a caterpillar tractor. The machine is self-propelling.

The operative has a seat on the platform which supports the operating mechanism. From this seat he can observe the action of the dipper and can also keep watch over the performance of the operating mechanism. The different motions of the shovel are controlled by levers. The dipper is forced into the pile of material by a movement imparted to the dipper arm and the pulling of the dipper chains. When the dipper is full the dipper chains are tightened so as to pull the dipper into a vertical position. The shovel is then swung on its turntable until the dipper is over the car. The bottom of the dipper is then tripped, allowing the material to drop.

At the Barr mine, in Kansas, near Picher, Okla., a type O Thew shovel was installed in April, 1919. This is a standard type, revolving in the full circle, and is self propelled, mounted on a 4-wheel truck. It was found to be more flexible than other loaders then being tried in the district, because the full-circle swing allows ore to be loaded at any point—front, back or to either side—within the radius of the boom. Three dipper loads fill a 1½ ton car. Over a period of twenty weeks'



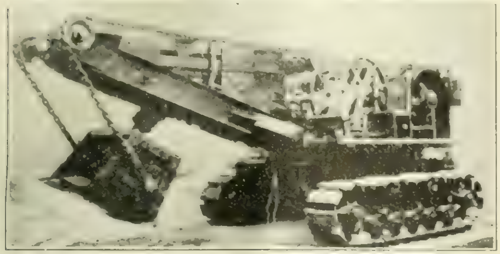
Shuveloder Loading from a Stockpile.

These machines are propelled by [illegible]. Immediately above the trucks and beneath the main body is a turntable that provides a traveling movement. The headroom required is 52 in. The machine will load any car 40 in. high or less.

operation the average loading per eight-hour shift was 160 tons at about one-half the cost of hand shoveling.

A crew consists of one operative, who should be a careful and experienced man; one helper, unskilled, and one mule driver and mule, handling 1½-ton cars. Such a crew, under suitable conditions, should easily load 175 to 230 tons per 9-hour shift. Table II shows the operating record for the period between Nov. 24, 1917, and Aug. 16, 1919, for one of the shovels at the Meloy mine.

A two-months' operating record for two shovels at the same mine in January and February, 1921, is given in Table III.



Thew Underground Shovel.

This machine is operated by electricity. It has a ⅝ cu. yd. bucket and a 20 hp. motor. The shovel revolves 360 degrees on a turntable.

Five Thew shovels were purchased by Witherbee Sherman & Co. The first shovel was purchased in September, 1917; two were purchased in 1918, and two in April, 1919. Three of these shovels were put into operation at their Harmony mine. In Table IV is given the record of these three shovels for the year 1920.

The ore was hauled away from the shovel in 54-cu. ft. gable-bottom cars. The Thew shovel in No. 2 stope worked against a 40-ft. face. The vein at this point was 60 ft. wide. Tracks were laid on either side of the shovel. The shovel loaded the car on one track and then filled that on the other while the first car was being trammed to the shaft and emptied. It took four minutes to dump the car and return it to the shovel. The shovel had difficulty in picking up large lumps and scraping the bed rock.

In 1918 the Chateaugay Ore & Iron Co., of Lyon Mountain, N. Y., introduced a Thew shovel into its No. 4 mine. Records of performance, cost and upkeep were not kept. Another shovel of the same make was procured for the No. 5 mine, but was used very little and was later transferred (March, 1919) to the No. 1 mine. Labor costs for the Thew shovel in No. 1 mine are: One operative, $5.25; one operative's helper, $4; three trammers, at $4 each, $12; total, $21.25.

Two hundred tons of ore was handled per shift, making a cost for labor of 10.62c per ton. This shovel worked in a large stope 40 ft. wide and 45 ft. high. Cars were pulled in and drawn out by mule. A switch was arranged 100 ft. from the shovel, and the cars pushed up to the shovel by hand for this distance. Side-dump cars of 40-cu. ft. capacity were used; they hold 2¼ tons. Much time was lost in switching cars.

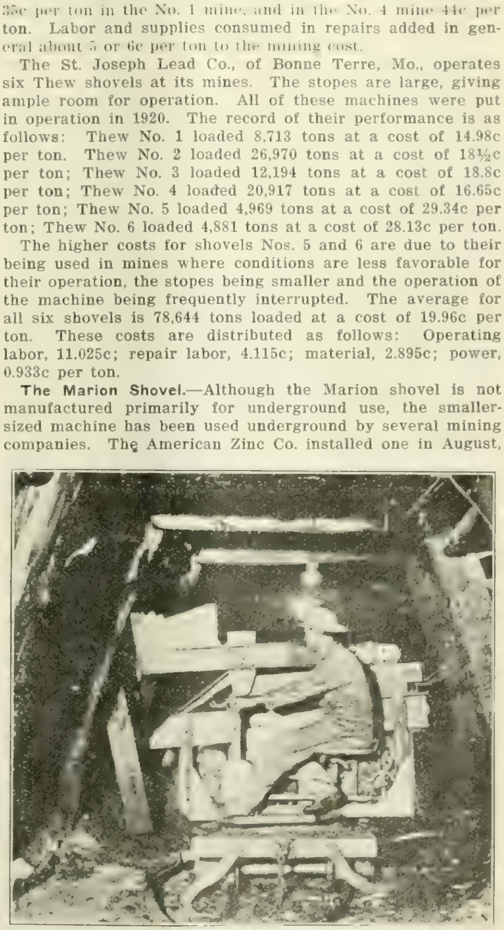
At the No. 4 mine also a Thew shovel was in operation. This shovel handles 300 tons per day, at a cost for labor of 6c per ton. A tail rope is used for switching cars. Two tracks lead to the shovel, so that one car is being loaded while another car is being pushed in. The shovel operated almost continuously. The full haul for cars is 600 ft. Alternating current at 220 volts was used. Power cost about 2½c per kw.-hr., or about $1 per day per shovel. The shovel was often out of commission on account of repairs. The most serious trouble experienced was the breaking of an I-beam on the No. 1 shovel. The rawhide pinions soon wear out, the average life being about three weeks. It is estimated by this company that the cost to handle ore by hand was 35c per ton in the No. 1 mine, and in the No. 4 mine 44c per ton. Labor and supplies consumed in repairs added in general about 5 or 6c per ton to the mining cost.

The St. Joseph Lead Co., of Bonne Terre, Mo., operates six Thew shovels at its mines. The stopes are large, giving ample room for operation. All of these machines were put in operation in 1920. The record of their performance is as follows: Thew No. 1 loaded 8,713 tons at a cost of 14.98c per ton. Thew No. 2 loaded 26,970 tons at a cost of 18½c per ton; Thew No. 3 loaded 12,194 tons at a cost of 18.8c per ton; Thew No. 4 loaded 20,917 tons at a cost of 16.65c per ton; Thew No. 5 loaded 4,969 tons at a cost of 29.34c per ton; Thew No. 6 loaded 4,881 tons at a cost of 28.13c per ton.

The higher costs for shovels Nos. 5 and 6 are due to their being used in mines where conditions are less favorable for their operation, the stopes being smaller and the operation of the machine being frequently interrupted. The average for all six shovels is 78,644 tons loaded at a cost of 19.96c per ton. These costs are distributed as follows: Operating labor, 11.025c; repair labor, 4.115c; material, 2.895c; power, 0.933c per ton.

The Marion Shovel.—Although the Marion shovel is not manufactured primarily for underground use, the smaller-sized machine has been used underground by several mining companies. The American Zinc Co. installed one in August, 1920, in its mines at Mascot, Tenn. Records of performance for three months are as follows: Total ore handled, 8,997 tons; cost, 19.7c per ton. Labor costs were 17.60c and repairs 2.11c. As this was a second-hand shovel the repairs were a little higher than usual.

A Marion shovel with ¾-yd. dipper is in use at the 1,650-ft. level of the United Verde Mine at Jerome, Ariz. The cost



Hoar Underground Shovel for Narrow Places.

This machine is operated by compressed air. It can be swung in a complete circle by a turntable underneath the body. It can be operated in a space 7 ft. wide by 6 ft. high. Its weight is 5,800 lbs. It works at 90 lb. air pressure using a 1½ in. air connection.

TABLE II—SHOVEL OUTPUT AT MELOY MINE

Total shoveled, tons	27,177
Total shifts worked	211
Average working time per shift, hours	3.85
Average tons shoveled per hour	33.4
Average tons shoveled per shift	129.3
Cost per ton.	**Cts.**
Labor	11.06
Power	0.79
Repairs	1.00
Total, cts.	12.85

Note—The cost of hand shoveling during the same period was approximately 23 cts. per ton. In both instances the tramming to the main haulage loop is included in the cost.

TABLE III—RECORDS OF TWO SHOVELS AT MELOY MINE.

	Total tons shoveled.	Total shifts worked.	Hours per shift.	Labor cost per ton.	Power cost per ton	Repair cost per ton	Total cost per ton
Shovel No. 1	10,987	80	7	11.7c	1.3c	0.7c	13.7c
Shovel No. 2	5,917	42	7	11.3c	1.3c	0.7c	13.4c

Note—The cost of hand shoveling during the same period was approximately 16 cts. per ton. In all cases the cost of tramming 200 ft. to the shaft was included in the labor cost.

TABLE IV. RECORDS OF THREE SHOVELS IN HARMONY MINE

	Thew No. 1	Thew No. 2.	Thew No. 3.
Tonnage	23,398	26,134	27,720
Distance trammed	158	210	395
	—Cost,	Cents per Ton—	
Operating, labor cost	16.2	14.9	16.0
Moving, labor cost	01.2	00.3	00.7
Repairs, labor cost	06.6	02.1	02.6
Repairs, supply cost	10.0	05.2	07.0
Shops and miscellaneous	04.1	01.6	01.9
Power	00.4	00.4	00.4
Total cost	38.5	24.5	28.6

of loading ore into chutes with this shovel is estimated as being less than for doing the same work by hand. The great weight of the machine makes it expensive to move in or out of a stope and because of its large capacity it often has to be kept idle waiting for ore. The advantage of the machine is that it loads material faster than it could be done by hand.

The Hoar Shovel for Narrow Quarters.—The Hoar underground shovel uses a dipper and is operated by compressed air, three sets of air engines being necessary to control the various movements. These air engines are mounted in the body of the machine. A turntable which allows the machine to be swung through a complete circle is placed between the body and truck. The truck runs on the ordinary mine track. The standard size machine requires an operating space 7 ft. wide by 6 ft. high. Its weight is [illegible] lb.; air pressure required, 90 lb.; air connection, 1¼ in.

The Hoar underground loader is not self-propelling and therefore must be pushed to its working place. It is then clamped to the rails. Having a full-circle swing the machine can load cars to either side or to the rear. The operative has a seat on the small platform on the left-hand side of the body of the machine. Being well above it he can observe the movement of the dipper. The machine is controlled by three levers which are placed conveniently for his operation.

In digging, the dipper is forced into the pile of material by the forward motion which the engine gives to the dipper arm. At the same time another engine winds the cable onto the drum which, acting as the lever, forces the dipper up through the pile. As soon as the dipper is raised free of the pile of material the entire machine is revolved on the turntable until the dipper is brought over the top of the car; then the bottom of the diper is tripped, allowing the material to fall.

The Hoar underground shovel has been introduced into only a few mining districts, the manufacturers having found a ready market in the Lake Superior iron mining district for their entire output. Little effort has been made to introduce the machine in other regions. It is being used in drifts, sublevelling work, stoping, to clear out dumps and also on the surface to shovel coal from the coal piles for use in boilers. The cost of operation varies considerably, depending upon the conditions, the range being from 17c to $1.08 per ton.

In shoveling the well-broken material in places where there was plenty of room, an average of 135 tons was loaded in 24 hours at a cost of 17.9c. The wages of the attendants were: Operative, $5 per day; helper, $4.75 per day. In another place, where the material was wet and sticky and contained many large lumps, the machine loaded over 8,500 tons in two months at a cost of $1.08 per ton. The mine management estimated that to have done the same work by hand would have cost $1.60 per ton. The wages of the attendants were: Operative, $8, and assistant, $6 per day. In the case of sublevel stoping, the machine handled more than 1,700 tons of material in one month at a cost of 65c per ton.

In the latter part of 1920 a Hoar underground shovel was put in operation at the Montreal iron mine. At the same time similar work was being done by hand, so that it is possible to compare the costs by the two methods. Comparison can be made between the work done on the 23d and 24th levels, the driving being done in the hanging wall in both instances. The type of ground was practically the same and the other conditions also were fairly equal. The 23d level drift was advanced using hand loading alone. The cost for labor was $11 per foot, over a period of 7 months, and during this time the drift was advanced 469 ft., or at the rate of 67 ft. per month.

In the 24th level east drift, the Hoar underground shovel was used and the drift was advanced 27[illegible] ft. in 3 months, or at an average of 90 ft. per month. The labor cost amounted to $6.[illegible] per foot and the repair and supply cost was $1.24 per foot, making a total of $7.[illegible] per foot. At the same time the shovel was used to handle material on the 24th level west at a labor cost of $6.21 per foot and supply and repair costs of $1.24 per foot, making a total of $7.45 per foot. The saving in the east drift of the 24th level was $4.14 per foot and the saving in handling the material from the 24th level was $4.55 per foot.

The Keystone Driller Co.'s Machine.—The Keystone Driller Co. has for several years manufactured and placed on the market an excavator mostly used on road work and also in digging cellars and ditches. This machine consists of an upright boiler with an engine mounted on a tractor, and a dipper operating on a boom. The Federal Lead Co. purchased several of these machines and remodeled them to be used in their mine at Flat River, Mo. In order to adapt the Keystone to underground mining it was necessary to replace the boiler and engine by an electric motor.

The operation of the machine as adapted by the Federal Lead Co., Flat River, Mo., is as follows: The operative stands on the main platform where the movements of the dipper can be observed. By levers, the boom can be lowered and the dipper pulled into the pile of material by a cable operating over the pulley at the end of the boom. The boom can be lowered, raised or swung by the second cable. As soon as the dipper is filled the boom is raised and swung until the dipper is brought immediately above the car. The bottom is then tripped, allowing the material to discharge into the car. The machine is given stability by two braces on either side of the machine at the front.

During the year 1917 in mine No. 12 48,917 tons of ore was shoveled by the Keystone shovel at a cost of 18.24c per ton. In 1919 in mine No. [illegible] 8,313 tons was shoveled at a cost of 19.11c per ton and in the same year in mine No. 12 318,819 tons was shoveled at a cost of 16.4c per ton. In 1920 370,373 tons was shoveled at a cost of 19.03 per ton. This makes a total of 746,000 tons of ore thus shoveled, giving an average cost of 17.85c per ton. The distribution of these costs is as follows: Tons of ore per shovel shift, 126.1; supplies and repairs, 2.10c per ton; maintenance labor, 12.57c per ton; power, 1.35c per ton; total, 17.85c per ton (sic).

The Golden Rod Mining Co. at Tar River, Okla., used a ⅝-cu. yd. Keystone shovel for loading ore. The shovel was operated for 3 or 4 months in 1918. The boiler was connected up as an air receiver, and the engine was run by compressed air. The ore was from 30 to [illegible] ft. thick. In this work the shovel did not prove satisfactory. It was mounted on a truck and was difficult to move around. The main reason for its failure was the necessity of emptying the dipper into 1,000-lb. cans; a large portion of the material was always spilled and had to be shoveled by hand.

Character of the Data.—For the records given in this article full credit should be given to Mr. Colburn's brief, which should be consulted in its entirety by those who are interested in this subject. The comment, however, on these shov-

TABLE [illegible] [illegible] OF HAND AND [illegible] LABOR, [illegible] MINE

	Hand [illegible]	[illegible] loading [illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

TABLE VI. TONNAGE LOADED AT SERVICE COAL MINING CO.'S MINE

Work Performed.		Cost.	
Cars loaded	41	Two men, loading, $7.50 per day	$15.00
Coal per car	2,800 lb.	One motorman, $7.50 per day	7.50
Total tons	582	Total	$22.50
Average tons per day	50.6	Cost per ton for loading and shifting	45c

TABLE VII. SAMPLE DAILY REPORTS OF COAL LOADING AT SERVICE COAL MINING CO.'S MINE

Number of cars loaded	37
Five moves	1 hour 30 min.
Two wrecks of loaded cars	1 hour
Total time loading and changing cars	5 hours

Number of cars loaded	40
Five moves	1 hour 20 min.
Splicing cable	30 min.
Total time loading and changing cars	5 hours 40 min.

Cleaned up four headings and one room.

Number of cars loaded	16
Waiting for power	1 hour

Arrived at face, 8:20 a. m.; left at 2:[illegible] p. m.

Total time loading and changing cars	3 hours 15 min.
Working force	One man and motorman

Pump broke down at boiler house making suspension necessary.

Number of cars loaded	35
Six moves	1 hour 10 min.
Waiting for cars	40 min.
Arrived at face	8:20 a. m.
Total time loading and changing cars	4 hours 50 min.

Number of cars loaded	44
Waiting for cars	40 min.
Arrived at face	8:40 a. m.
Total time loading and changing cars	5 hours

Loaded ten cars out of one room in 1 hr. and 8 min.

els has another source, for the most part, especially the reference to coal-mining conditions underground. The bulletin gives valuable data also regarding the use of scrapers in metal mines, where such machinery has long been in successful use. Unfortunately the labor costs in the bulletin are mostly in dollars and cents and not in labor units, which would be more readily translatable. As wages have varied they are not even comparable as between the various years' experience in the same mine. As interest, depreciation and obsolescence are omitted, the figures are likely to be misleading. These items often spell the difference between acceptance and rejection. In some cases, however, repairs which should have been covered by earlier depreciation allowances have caused costs to be unduly high.

Reciprocating vs. Rotary Car Feed to Shovel.—There is little question but what the machinery described in the bulletin should find general use in coal mines, where the conditions are not so difficult as to make the machines unavailable. The factors militating against their use are the difficulties with labor and the lack of sufficient and efficient superintendence. To a machine having large capacity a continuous supply of cars must be afforded. The heavier and more expensive the machine, the more need for such attention; otherwise the overhead costs will decrease the profit materially. In fact, so important is this feature that manufacturers having in mind the multiplicity of narrow workings and the almost inevitable irregularity of car supply are providing units of small size and of less efficiency, which they feel assured will suit the needs of the coal industry better than larger machines of greater capacity but also of greater cost.

The Jeffrey mine-car loader is designed on the principle that when the car movement is reciprocating and not rotary (if these terms may be excused) it never can be really satisfactory. Where cars must be brought to the loader and backed away after being filled, delays are inevitable. Only when trips can be steadily passed by the working face and taken out another way can a car be presented to the shovel for loading as soon as the previous car is filled.

Simple vs. Inter-Related Shovel Efficiency.—Hence, it is argued that as delays are inevitable it is well not to tie up too much money in a shovel, even if by having a less efficient machine the time of loading is somewhat increased. Suppose one shovel can load a car in two minutes and has to wait ten for another, its actual capacity is only one car in twelve minutes. If then another takes ten minutes to load a car and then has to wait a further ten minutes before loading the next, its actual capacity is one car in twenty minutes.

Thus though the first shovel appears to have five times the capacity of the other, the actual capacity is not five times but only 66 per cent greater. When the car delays are longer, and they always are likely to be, then the percentage of relative capacity will fall still lower. Only ideal conditions will enable cars to be presented so fast that the delay between cars will not exceed ten minutes. The time taken in moving the shovel from one working place to another will still further diminish capacity. It is this which has made the large-capacity shovel less effectual than at first sight it would appear to be. The large first cost which adds so much to the expense of operation and the idle time which seems inevitable under present operating conditions add to the argument against such shovels.

Loaders therefore that are not shovels but mere loaders which themselves have to be loaded, but being loaded will raise the coal, transfer it and drop it into the car, seem to have a reason for being which their lower speed of operation and their imperfect service would seem to deny them. They also are more flexible and can be used where the roof is not particularly good and the coal is thin. Consequently this machine, which is loaded by hand shoveling, is rated at 50 to 60 tons a day under actual working conditions in rooms and each machine is intended to get its output from two working places only. The handling of the cars should be carefully planned that tracklaying, timbering and the like is not done by the loading crew.

The Service Coal Mining Co., at Fordham, Pa., made the record in Table VI with a mine-car loader of the type mentioned, between Aug. 16 and Sept. 1, 1921, in the Lower Freeport seam which ran from 46 to 54 in. thick. The mine worked 11½ days. Two men operated the machine and one motorman provided cars.

The daily reports are given in Table VII. They show that much time was wasted waiting for cars. The coal was loaded from headings which made many more moves per day necessary than would be required if the coal had been obtained from rooms.

It will be seen that this record might have been bettered had conditions been a little more favorable—for instance, had fewer moves been necessary, the tracks been such as to reduce accidents, the power been steadily available and the runs been longer.

Kinds of Haulage and Cutting Machines in Coal Mines

By W. W. ADAMS,

Statistician, U. S. Bureau of Mines

The extent to which coal mines have installed various types of haulage systems and mining machines is a subject about which there is little definite information available in convenient form for the country as a whole. A few State mine inspectors include in their annual reports such information for their respective States, but uniform data for the United States have not until recently been compiled.

Several years ago the Bureau of Mines compiled from one of the standard mining directories† a statement showing the kinds of machines and haulage used in coal mines. The first statement was prepared from the 1918 edition of the directory in which detailed descriptions of coal mines were given. The information presumably related to the calendar year 1917. Similar statements have been compiled from the directories for 1919, 1920 and 1922, the statement for 1921 having been omitted because the directory for that year did not become available.

The latest statement is given below and is based upon the directory for 1922. It relates to conditions prevailing in 1921, and covers a total of 7,088 coal mines. Of these, 5,064 mines, or more than 71 per cent, were using animal haulage. As compared with the total number of all classes of mines, those in the animal-haulage group constituted 71.4 per cent, the percentage having remained practically stationary during the past four years, although the actual number of mines in the group has increased. Rope haulage was reported by 1,066 mines, or 15 per cent of the total, representing a larger number of mines than in 1918, but a decrease of 2 in the percentage for the group as compared with all classes of mines. Electric haulage was reported by 3,274 mines (46.2 per cent), and the number of motors in use was 11,265. The percentage of mines in this class has not changed materially, but the actual number of mines has shown a gain of about 900 during the past four years. Compressed-air locomotives have not increased either in actual or relative number, the percentage for the past year being but 1.2. The number of mines using storage-battery locomotives has increased from 3.6 per cent of the total shown four years ago, to 9.8 per cent for last year, the latest figures showing 693 mines with 1,428 locomotives. A total of 405 gasoline locomotives was reported by 271 mines, the number of mines representing 3.8 per cent of the total, practically the same percentage as in previous years. Steam locomotives numbering 1,069 were reported in use at 528 mines and pits which is 7.4 per cent of the total, a very slight decline from past years.

Coal was mined by hand in 3,332 mines, 47 per cent of the total number, indicating an increase in the number of mines in this group, although the percentage has not changed materially. Electric cutting machines, 17,875 in number, were reported for 3,607 mines, which is 50.9 per cent of all mines reporting. Compressed air machines were employed in only 288 mines, or 4.1 per cent, and the number of machines in use was 2,159, both figures being smaller than those for previous years.

Stripping operations were shown for 146 mines and the number of shovels was tabulated as 72. While the former figure is perhaps too low, the latter figure has practically no value, because the descriptions of open-pit mines frequently failed to state the number of shovels in use.

The outstanding features of this statement are the figures showing the large number of electric motors and electric cutting machines that have been installed in coal mines, and, simultaneously the extent to which animal haulage and hand methods of mining still prevail.

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*Reports of Investigations, U. S. Bureau of Mines.

†Coal Field Directory, published by Keystone Consolidated Publishing Directory, Pittsburgh, Pa.

Railroad Ditcher Operations on C. R. I. & P. Ry.

How the Chicago, Rock Island & Pacific Ry. obtained better results from its railroad ditchers and reduced the cost of ditching and filling with them was told by [illegible], for general supervisor of work equipment of the railway, in a recent issue of the American Ditcher [illegible]. We quote from his article as follows:

When, as the incumbent of the newly created office of supervisor of work equipment on the Rock Island, I made my first inspection trip to ascertain what equipment there was and what should be done with it, I located five steam ditching machines and one air ditching machine. One steam ditcher was in service and the others were stored: two in abandoned gravel pits and two at shop points. The air ditcher was set aside on a scrap track at one of the large shops. The ditcher in service was operating on a branch line using 20 flat cars, an unloader engine, three plows (right, left and center) and a bank leveler or spreader. This ditcher would load the flats, then proceed to plow them off and level the dirt with the spreader.

Having located and overhauled this equipment, it was then organized into separate outfits, each comprising one ditcher, 20 flat cars, three plows, an unloader engine and a bank leveler. This, with the locomotive, caboose and one tool car, made a train of 25 cars, upon the completion of which work assignments were requested for each of the outfits.

Dumper Cars Replace the Flat Cars. The assignments were granted, but the showing made did not come up to expectations. I felt that something was wrong and started out to investigate. The first roadmaster interviewed said he could not use the ditching outfit on his main line track. He could use it on the branch lines, but could not get an appropriation to spend the money on branch line work. He explained his position about like this: "You know our main line is busy. We call it a 15-minute service and we cannot hold trains. This means that the ditcher must leave a siding, go to a given point, operate and get back in clear in ten minutes, handling 20 or more cars." As a possible solution of this problem the 20 flats with the Lidgerwood and plows were replaced with two dump cars. The roadmaster was very much pleased with this arrangement and handled the ditcher the entire season on his main line with an average performance of over 200 yd. per day.

How the Cost of Ditching Was Reduced.—All the ditchers were equipped this way and I felt that we were doing well. In fact we were doing so well that the roadmasters were anxious to have a ditcher. However, at the end of the year, when accounts were made up it developed that the cost of ditching was too high, some of the work running up to 80c per yard. The reasons for this, as it appeared, were two: first, the dump cars were crude and costly to operate, and second, most of the ditching was done in wet weather. To operate the dump cars it required four men to handle the levers. Furthermore, if the dirt was dry and sandy, although the cars dumped easily, considerable dirt would invariably fall back over the rail and require shoveling off. On this account it was found necessary to use six men instead of four to clear the tracks quickly. If the dirt was wet the cars would have to be cleaned with shovels and this called for all the men available, including the section men, to avoid hiring more men in the ditcher gangs.

To reduce the cost of ditching, therefore, two things had to be done: first, to procure quick acting dump cars; second, to do the ditching in dry weather. To get the cars would cost money; to get the ditching done in dry weather would call for enough ditching machines to get ahead of wet track, that is, to get the worst wet places ditched during dry weather, so that when it rained the water would run off instead of lying there until a ditcher was sent to cut a drain.

Both of these plans, however, worked out satisfactorily, as a result of which the cost of ditching was reduced to [illegible] per yard in 1917 and was kept at about [illegible] per yard when the bonuses were scheduled in 1919 and 1920. The output was increased from [illegible] and [illegible] per day with the [illegible] trains to an average of [illegible] per day with the dump car trains.

Housing and Hiring Ditcher Crew. Good practice called for a close study of the ditcher organization and some drastic changes. While the first essential is a man at the head of the work familiar with machinery and men, good machines and good reliable men are also essential; and men require careful attention. They must be kept comfortable and satisfied, have good living conditions and some one to see that they get what they need in the way of supplies and repairs.

With this in mind many things were done, an enumeration of some of which may prove interesting. On this road the ditcher works the entire year, north in the summer, south in the winter. Ditching and filling small bridges form the principal work. As a result the crew must live in a car continually, excepting for short periods when they are able to visit their families. In order, therefore, to provide comfortable quarters for eating, sleeping, resting, making out reports, etc., old cars were taken and rebuilt throughout. The ditcher engineer was allowed to furnish the car in any way he wished, and many changes were made to conform to the ideas of the men.

On account of the low rate of pay allowed for ditcher firemen, young men were hired, preference being given to boys just out of good schools or colleges. They almost invariably developed into engineers and jobs were procured for them on other roads if we could not place them. Firemen are assigned permanently in the same way as engineers to certain ditchers and all assignments were made so as not to allow "bumping" by other men. The oldest fireman served also as an extra engineer and was thus available for relief work when regular engineers were off duty. The organization was also such that engineers were allowed to hire local men to replace a fireman temporarily.

Improvements in the Ditchers.—The ditchers themselves were equipped to carry one day's supply of coal, thus necessitating coaling in the morning only. Another improvement was made by running water pipes from each ditcher through each dump car to the locomotive tender. With this arrangement it was possible to take water while the train was running, thus doing away with any delay consequent on the limited capacity of the water thanks on the ditchers. To improve the performance of the ditchers further many features were also introduced with reference to the machinery and as a result of all the changes the ditcher equipment became the least prominent of the causes of delay given.

Device for Clearing the Dump Cars.—One improvement, which helped considerably in avoiding delay on the work was a device for cleaning the dump cars. When working in wet dirt the cars required cleaning, as the mud would stick to the bottoms. To avoid the delay of shoveling this, a heavy board was made, pointed or sharpened on one end, and a chain applied to the other end so that it could be handled by attaching it to the dipper. When using this the car was tilted, after which the mud could be cleaned off in a few minutes.

The cars were dumped by pulling a cord attached to the platform of the caboose and small home-made spreaders were used, each having a nose which could be lowered to the rail. In this way the rail could be cleaned by a movement of the train and much shoveling was avoided.

The ditcher outfits were assigned to divisions and the trains "bid in" by crews. No inquiry was made as to whether these crews had experience in ditching, and this did not really matter, excepting that in some cases, where a roadmaster would give the conductor entire charge of the job, the latter would attempt to instruct the ditcher engineer. However, there were but a few of such cases and in each case it developed that the ditcher engineer was doing poor work. This trouble was overcome by requesting the roadmaster to make two copies of his instructions, giving one to the conductor and one to the ditcher engineer, both men thus knowing exactly what was wanted and having no reason for hindering the work.

Municipal Rail Lines in Germany Lose Money. It is reported from Paris that 80 per cent of the surface lines in Germany continue to operate at a loss. Most of these lines are publicly owned.

In some instances competing private lines meet their expenses and paid small dividend.

In Hamburg the municipal lines, which are considered the most efficiently managed in Germany, were barely able to break even.

These facts and figures are official and are taken from the companies' statements and from reports of Berlin's transportation chief.

73-Year-Old Locomotive in Service in England*

Much interest has been caused recently by the reappearance of the famous London & North Western locomotive "Cornwall" in main line service.

The "Cornwall" was built during that period of English railway history known as "the Battle of the Gages," occasioned by the policy of the then Great Western directors, acting on the advice of their engineer, Brunel, in adopting the 7-ft. gage as against the 4-ft. 8½-in. gage inaugurated by Stephenson and used on all other lines. Excellent records for speed having been claimed for the Great Western 8-ft. single driver express engines, Francis H. Trevithick, then the locomotive engineer of the London & North Western at Crewe, and a strong advocate of the narrow or 4-ft. 8½-in. gage, built, in 1847, the engine "Cornwall" having single driving wheels 8 ft. 6 in. in diameter, with the idea of showing that whatever could be done in the way of speed on the broad gage could be equally well done on the narrow. The engine was completed in November, 1847, and when first built the boiler was placed below the driving axle in order to obtain a low center of gravity. Two steam domes were fitted to the original boiler, each joined together by an internal steam pipe taking steam to the "outside" cylinders, which were 17½ in. by 24 in. A safety valve was fitted to each dome.

It does not seem to be quite clear as to how many wheels the engine had when first built; some say eight were used—four in a group at the leading end, but not in the form of a "Truck" or "bogie," then the drivers and a single pair at the trailing end. Drawings of the engine thus equipped have several times appeared, but it is thought that such an arrangement was only proposed prompted by the fact that several Great Western engines of the period were so designed, and that in reality the engine always ran on six wheels. In 1858 the engine was rebuilt with a new boiler placed above the axle. Before being rebuilt the engine was shown at the London Exhibition of 1851. It is also reported to have attained a speed of 117 miles per hour down a grade between Madeley and Stafford on the North Western main line. After being rebuilt a second time by the late F. W. Webb, the engine was stationed at Edgehill, near Liverpool, in 1890, and was principally used in running the 45-minute express trains between Liverpool and Manchester. The "Cornwall" was taken off the Liverpool and Manchester trains in 1902, and finally was taken out of service in August, 1905, being considered amongst those whose work is done. The engine was actually in work 58 years, and from the time it was rebuilt in November, 1858, to August, 1905, it ran 928,838 miles. No record of her mileage prior to 1858 is available.

After being taken out of service the engine was used for the Chief Mechanical Engineer's private coach; the coach, which runs on six wheels, being arranged with a coal bunker at one end, was coupled direct to the engine, a tender being dispensed with.

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*From the Railway Mechanical Engineer.

Hints for Job Getting

Some useful suggestions on securing positions were given by the Voluntary Committee of the Employment Service of the American Society of Civil Engineers in the May Proceedings of the Society. We quote as follows

1. Decide on what you want

2. Make sure your qualifications give you an even chance of getting it. Do not think 100 per cent is necessary. Perfection does not exist.

3. Do not go after a job unless you mean business.

4. There are three factors to every job, viz., advancement, experience, salary. Do not ignore the first two.

5. Remember that the job gets the salary, not the applicant's qualifications.

6. Job getting is selling one's services. The successful salesman knows his product thoroughly. Study your goods.

Letter Writing.

1. The object of a letter is to get an interview. Letters do not get jobs.

2. Padding of payrolls is a felony. Padding of letters is equally dangerous for the job hunter.

3. A letter must: Arouse interest; create desire; prove the case; and convince the reader that an interview will be profitable. Therefore: Be as brief as is consistent to prove your claims. Make no claims not backed by the experience record. Always include the experience record.

4. Attractive packages improve the sale of goods. Therefore, typewritten letters on plain business stationery are better than long-hand letters on club or personal stationery.

Interviews.

The interview is "the day in court." Getting it is only one-half the battle. When being interviewed:

1. Be confident of your work, but not presumptuous.

2. Be sure you want the job and be ready to prove why you should get it.

3. Ask a fair market price for your goods. Do not profiteer. Do not be a philanthropist.

4. Assay the three elements: Advancement, Training, Salary, and be guided by the sum of the three in accepting or declining.

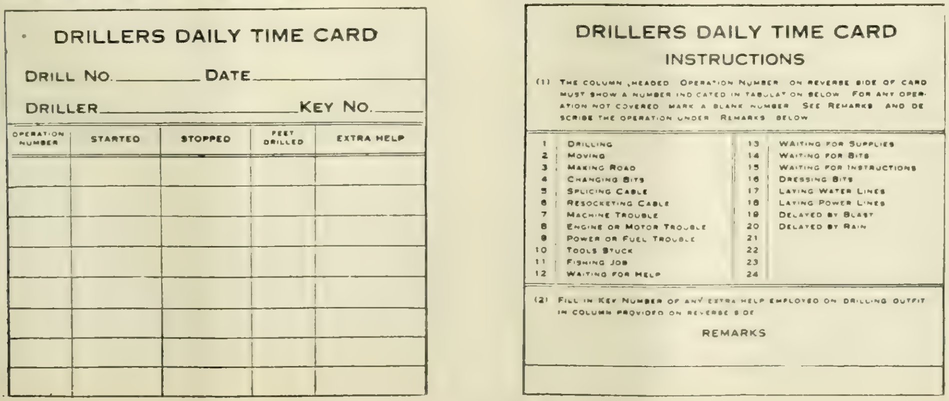
5. Leave in a pleasant, hopeful manner if the job is not decided then and there.

6. A letter of acknowledgment of the courtesy of an interview is good policy following a promising call.

Finally, maintain the proper mental attitude. Do not let your morale slump. No one wants a grouch or a man who is not sure of himself.

Daily Time Card for Drillers

A useful card for recording the daily time and operations of drillers is reproduced below from "Big Blast Hole Drills," a publication of the Sanderson Cyclone Drill Co., Orrville, O. Very little time or effort is required of the drillman in filling out the card. Practically all operations in big hole drilling are designated by numbers, and these are used by the drillman in filling out his time card.



DRILLERS DAILY TIME CARD

DRILL NO.________ DATE________

DRILLER________________KEY NO.______

OPERATION NUMBER	STARTED	STOPPED	FEET DRILLED	EXTRA HELP

DRILLERS DAILY TIME CARD

INSTRUCTIONS

(1) THE COLUMN HEADED OPERATION NUMBER ON REVERSE SIDE OF CARD MUST SHOW A NUMBER INDICATED IN TABULATION BELOW. FOR ANY OPERATION NOT COVERED MARK A BLANK NUMBER. SEE REMARKS AND DESCRIBE THE OPERATION UNDER REMARKS BELOW

1	DRILLING	13	WAITING FOR SUPPLIES
2	MOVING	14	WAITING FOR BITS
3	MAKING ROAD	15	WAITING FOR INSTRUCTIONS
4	CHANGING BITS	16	DRESSING BITS
5	SPLICING CABLE	17	LAYING WATER LINES
6	RESOCKETING CABLE	18	LAYING POWER LINES
7	MACHINE TROUBLE	19	DELAYED BY BLAST
8	ENGINE OR MOTOR TROUBLE	20	DELAYED BY RAIN
9	POWER OR FUEL TROUBLE	21	
10	TOOLS STUCK	22	
11	FISHING JOB	23	
12	WAITING FOR HELP	24	

(2) FILL IN KEY NUMBER OF ANY EXTRA HELP EMPLOYED ON DRILLING OUTFIT IN COLUMN PROVIDED ON REVERSE SIDE

REMARKS

Front and Back of Daily Time Card.

Chemical Killing of Weeds on Railway Roadbeds

[illegible] interesting information on this subject was given by a committee report presented at the last annual meeting of the American Railway Engineering Association. We quote from the report as follows:

Chemical weed killing was first introduced in [illegible] by Dr. [illegible] of Galveston, Tex., and a limited success in a restricted area of application was attained by him. According to statements in present reports chemical weed killing was started in 1911 and 1912 with a few roads treating moderately long stretches of track. The war interfered with its progress, but since then during the last few years it has been resumed and is now being followed rather vigorously, thousands of miles of railway and trolley lines being treated each year, and in yearly increasing mileage. One contracting company has at the present time seven trains equipped for this work. The scarcity and high rate of labor has, no doubt, stimulated this method of weed killing.

The Chemical.—The chemical mostly used, so far found out, is a mixture or compound of arsenic and caustic soda, using 8 to 10 per cent of the latter by weight, dissolving the solid chemicals in water. The chemical is shipped in accordance with needs or demands in cans, barrels, drums or tank cars, in concentrated form and diluted with water at the place of application as circumstances require, which is usually one part of the concentrated chemical to 18 or 20 parts of water, with the arsenic-caustic soda combination referred to above. The application is made on any desired scale from a hand car, single flat car, or entire train, all with proper equipment.

How the Chemical Is Applied.—The fully equipped train is the only method with which to work economically on a large scale. The train is made up of 6 or 8 cars. The front or pilot car of the train contains the sprinkling apparatus composed mainly of pipes, perforated with small holes or nozzles for the emission and diffusion of the poisoning liquid, valves, meters, etc., all under the complete control of the operator. In the same car are pumps and air compressors actuated preferably by motors of Marine type, to impart pressure to the liquid, in applying it to spraying the weeds and to furnish compressed air for mixing the diluting water with the concentrated chemical. The liquids are thoroughly mixed by means of compressed air before application. In the after part of this car may be living quarters for the crew. The main part of the train is made up of tank cars—all connected together with lines of pipes and fully supplied with valves, meters, all necessary appliances. One of these tank cars is loaded with the concentrated solution which is drawn out as needed. The other tank cars carry a supply of the chemical diluted to the strength for spraying on the weeds. The last tank car contains Repellant, a liquid to be sprinkled over the weeds after the poison has been applied at road crossings, station grounds, etc., at places where cattle are liable to browse on the vegetable growth and be poisoned by the compound. This Repellant is bitter or contains something disagreeable to grazing stock; this, however, appears to be of doubtful value. Last of all comes the locomotive pushing the trains. Before starting to sprinkle—the tank cars carrying the diluted mixture are filled. The concentrated chemical is drawn from its storage car and mixed 14 to 20 parts more or less of water as practiced by the company with largest equipment and doing most treatment on the roads, while another company dilutes with equal volumes of concentrate and water. Thus the amount of solution must be determined in each case from the strength of the solution and the vigor of growth and thickness of the stand and kind of species of weeds to be killed.

The volumes are measured by meters and gages. The tank cars ought to contain enough liquid to reach to the next water station, [illegible] miles or more. The solution is applied at a speed of about [illegible] miles per hour, and as [illegible] freight or local trains at a [illegible] there is no interference with traffic. When the next water station is reached a stop of an hour is made, although half an hour is usually long enough to refill the empty tank cars with another supply.

Rate of Application.—The rate of application in volume per unit of area varies according to conditions as much or even more than the strength of solution. A very convenient unit of measurement is gallons of solution per foot of width per mile of roadbed, which appears to be ordinarily within the limits of 5 and 15, or a minimum application of 5 gal. for width of 8 ft. will take 40 gal. per mile, while a maximum application of 15 gal. per foot for 14 ft. width will take 210 gal.

The rate of spraying per unit of surface is regulated either by controlling the amount of liquid allowed to escape from jets, which can be made under the control of the operator, or by varying the speed of the train or by both means. The rate of emission should be directly proportional to the weed growth and must be controlled by the judgment of the operator.

When the Chemical Should Be Applied.—It is claimed by some roads using the chemical weed killer that the weeds should be allowed to attain their full growth before application, so that the sap in descending the stocks will carry the poison to the roots. Others claim that the chemicals should be applied to the growing weeds in order to eliminate them from the roadbed, during the summer season. It should be applied before cutting the weeds, as cutting causes the weeds to seal over the cut, preventing the poison penetrating to the roots.

It should not be applied immediately after a rain as the cells of the weeds will be full of water and prevent much poison entering. It is claimed in some reports that the chemicals should not be applied immediately before rain, as rain washes the solution away so it will not enter the plant. It is claimed by others that rain after application is beneficial, because the solution being dried, is redissolved by the rain and is then absorbed by the plant.

It is claimed by the advocates of chemical weed killing that successive application in lessening quantities per year for three years will completely extirpate the weeds, and the only ones afterwards growing will come from seed blown or carried in on the right-of-way. It is also held that the ground may be completely sterilized by the chemicals so it will not grow weeds, but no instance of it actually being done has been given. Only one case has been reported so far of complete killing of weeds after three years' application. Some reports indicate that the most effective method is to make the first application so strong that all the weeds are killed—that successive weak applications tend to make the weeds immune. Some grasses and weeds, such as Johnson, Bermuda, Salt, Blue Stem, Wire, Crab Grasses, Horsetail, Ragweed and Bull Thistle do not appear to be killed by a single application, and their complete destruction is still a problem.

One road reports that after four years' application it was decided to discontinue entirely the use of the weed killer and resort to the weed burner, claiming that the "weed killer" did not destroy all the weeds and those that did succumb were dried and left to foul the ballast and otherwise giving an unsightly appearance to the roadway, and also that the cost was far in excess and also the results less satisfactory with the weed killer than with the weed burner.

Killing Weeds with Common Salt.—Attention is directed to the application of common salt to weeds on 454 miles of the Erie R. R., as reported by Mr. I. H. Schram, Regional Engineer. The salt was applied from the car by shoveling on chutes which made the distribution in work train service at the rate of 0.8 car loads per mile. The cost was for labor

SUMMARY OF DATA RECEIVED

Road.	Date	Miles.	Per Mile— Gals.	Per Mile— Cost	Solution	Remarks
Balt. & Ohio...	1912	20				
Balt. & Ohio...	1918	565	34.8	25.73		
South. Pacific..	1920	2,000	92.5		1-20	1920 and later
South. Pacific..	1918			[illegible]		First treatment
South. Pacific..	1918			35.00		Second treatm't
South. Pacific..	1919			[illegible]		First treatment
South. Pacific..	1919			[illegible]		Second treatm't
Illinois Central	[illegible]		75	[illegible]	1-12&20	
Frisco	1921	175	129	[illegible]	1-12&20	First treatment
M. K. & T.	1919	20				
M. K. & T.	1920	245	[illegible]	[illegible]		
Santa Fe	1919	[illegible]		[illegible]		G. C. & S. F.
Santa Fe	1920	[illegible]		[illegible]		Western Lines
Santa Fe	1921	[illegible]		[illegible]		South'n District
Santa Fe	1921	[illegible]		[illegible]		Plains Division
Santa Fe	1921	[illegible]		[illegible]		Dayton Division
Southern Ry. ..	[illegible]	[illegible]	112	[illegible]		May and June
Southern Ry. ..	[illegible]	[illegible]	85	[illegible]		June, July, Aug.
Southern Ry. ..	1916	[illegible]	50.8	[illegible]		August, Sept.
Southern Ry. ..	[illegible]	[illegible]	37.8	[illegible]		August, Sept.
Union Pacific ..	[illegible]	[illegible]		[illegible]		
Union Pacific ..	[illegible]	[illegible]	102	[illegible]		
Union Pacific ..	1918	147.1	101	[illegible]		
Union Pacific ..	1919	119.1	81	[illegible]		
Union Pacific ..	1921	[illegible]		[illegible]		Weed burner

Manufacturers Distribution of Cost.

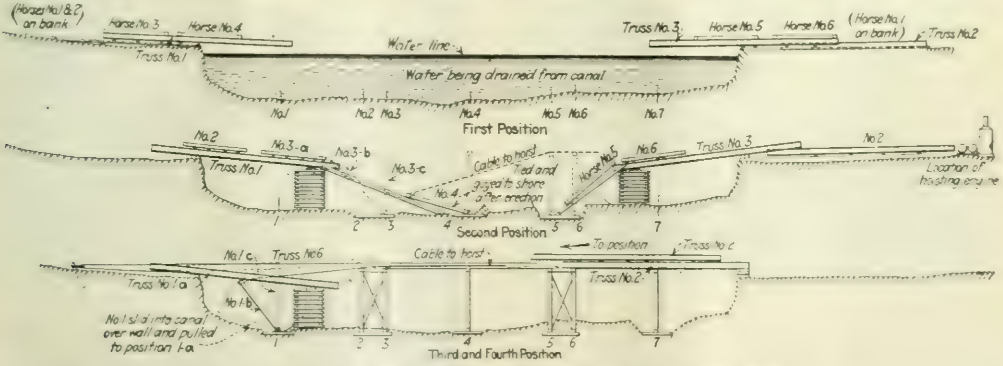
Chemical	$0.60075
Manufacturing	0.053
Spreading	0.1205
General Expense	0.0416
	$0.81585

and train $13.40 per mile, for foreign freight $18.75, total $32.20. The cost of hand weeding in that district has been $73.33—which gives cost of salt application 44 per cent of cost of hand weeding. The salt was good mined salt, but rejection from crusher account being too coarse for market, and was received without cost. Approximately 40 tons per mile was used. The application was very effective and killed all the weeds. In this part of New York, in the vicinity of Rochester, salt has been used for a number of years for weed killing. Care, however, must be exercised in its application to prevent interference with automatic signaling.

Emergency Electric Railway Bridge Built in 11 Hours

A remarkably quick piece of temporary bridge construction under difficult circumstances was carried out last December by the Holyoke (Mass.) Street Railway, under the direction of George E. Pellissier, assistant general manager. We are indebted to the Electric Railway Journal for the following details and the illustration.

This emergency job was necessary on account of a misunderstanding as to temporary diversion of electric railway traffic during the construction of the new "Valley Bridge" over the second level canal in Holyoke. The railway company had only five days available to secure the material necessary for the trestle, to fabricate it and to deliver it at the bridge site, and only one day available to erect the structure. It was possible, through the courtesy of the Holyoke Water Power Co., to draw the water out of the canal. It required until 11 a. m. Sunday to do this, however, and as the paper mills which draw water from this canal all had to resume operations early Monday morning, it was necessary to let the water back into the canal beginning soon after midnight. A total of but 15 hours was available from the time the first work could be done until the job was completed and all materials, tools, etc., had been removed by the company from the canal bed.



Steps in Erection of Temporary Electric Railway Bridge at Holyoke, Mass.

Soundings made before the water was drawn out showed that the canal bottom was soft ooze. Provision was made, therefore, for building cribwork on the bottom and timbers were framed to make up seven supporting horses. The horses were framed near by and slid into place by means of rollers and a donkey engine. The steel I-beams were lifted into place by means of the rigging shown in the accompanying drawing, in the following manner:

These horses were framed on the banks of the canal while the steel beams were being assembled and bolted together in three sections, each 50 ft. long. On two sections of steel work, one on either side of the canal, two complete horses were placed and the steel sections with their horses were mounted on rollers on the banks of the canal. While the water was being drawn out of the canal these steel sections were hauled out over the canal by means of a donkey engine (the only power equipment available for the job) until the sections were practically balanced on the edge of the wall.

As soon as the water was out of the canal a crib was made of ties on the bed of the canal under the ends of the projecting steel beams just high enough so that when the steel beams were tipped down they would strike a roll on top of the crib and slide right into place with one end of the beam resting on the bed of the canal. The two horses on these beams were thus deposited practically in their proper position and, being on an incline, very little effort was necessary to pull them into upright position and bolt them together to form the double horses or piers which are shown in the accompanying elevations.

The intermediate horses were then dropped over the wall of the canal and placed under the steel beams resting flat on the bottom but with their bases in their final position. A couple of stakes were driven to keep these bents from sliding and a line from the donkey engine to the top of the bents pulled them into an upright position. As they came up they lifted with them the two steel beams, which of course would then be in their final resting place. One of the sections was then used for a run to roll out the middle section end of the trestle, using the donkey engine for motive power.

Production of Explosives in 1921

The quantity of explosives used in the United States during the calendar year 1921 was lower by more than 30 per cent than the amount consumed in 1920, according to the U. S. Bureau of Mines. Reports received by the bureau show that the total sales amounted to 372,107,503 lb., as compared with 537,954,750 lb. the year before. Of the total amount sold 160,021,250 lb. (43.0 per cent) was black blasting powder, 170,952,402 lb. (45.9 per cent) "high" explosives other than permissible explosives, and 41,133,851 lb. (11.1 per cent) permissible explosives. As compared with the preceding year these figures indicate a reduction of 37.2 per cent in sales of black powder, 25.4 per cent in "high" explosives, and 23.8 per cent in permissibles. Permissible explosives are those which, because of having passed certain tests prescribed by the Bureau of Mines, are considered reasonably safe for use in gaseous and dusty coal mines.

The coal mining industry is always the largest consumer of black powder and permissible explosives, the consumption usually comprising about 85 per cent of the entire amount manufactured. In 1921 the coal mines used 5,613,435 kegs or 140,335,875 lb. of black powder, 34,231,542 lb. of "high" explosives, and 38,055,650 lb. of permissibles, representing decreases of 36 per cent, 8 per cent and 16 per cent, respectively, as compared with 1920.

Metal mining and all other mining (excluding coal) used 184,792 kegs or 4,619,800 lb. of black powder, 50,977,366 lb. of "high" explosives, and 881,710 lb. of permissibles, indicating decreases of 47 per cent, 43 per cent, and 76 per cent, respectively, below the year 1920.

Railroad and other construction work was the only branch of industry using a larger quantity of any kind of explosives than in 1920. This class of work consumed 18,317,333 lb. of dynamite and other high explosives as compared with 15,052,608 lb. the year before, but there was practically no change in the quantity of permissibles, while the consumption of black powder declined from 196,172 kegs in 1920 to 163,688 kegs in 1921.

The quantity of explosives used for all other purposes fell off 49 per cent for black powder, 59 per cent for permissibles, and 23 per cent for other high explosives.

Cost of Passenger Platforms on Pennsylvania R. R.

As an appendix to a committee report presented at the last annual convention of the American Railway Bridge and Building Association, Mr. H. Stilcox submitted the following costs of passenger platforms of the Pennsylvania System, based on 1921 prices of material and labor.

VITRIFIED BRICK BLOCK PLATFORM

Specifications—6 in. concrete base, 2 in. sand cushion, 2 in. by 24 in. limestone headers and curb with tie rods placed 3 ft. 6 in. centers.

Cost of 3 ft. 6 in. section of 12 ft. platform—

2 cu. yds. excavation and disposal @ $2.00	$ 4.00
[illegible] cu. yds. concrete in place @ $[illegible]	15.55
¼ cu. yd. sand cushion @ $3.00	.75
Vitrified blocks in place @ $80.00	16.00
1 tie rod in place @ $2.00	2.00
7 lin. ft. curb in place @ $1.50	10.50
	$48.80
10% contingencies and overhead	4.88
Total	$53.68
Per square foot	$ 1.24

VITRIFIED BRICK BLOCK PLATFORM

Specifications—18 in. cinder base, 2 in. sand cushion, 2 in. by 24 in. limestone headers and curb with tie rods placed 3 ft. 6 in. centers.

Cost of 3 ft. 6 in. section of 12 ft. platform—

3 cu. yds. excavation and disposal @ $2.00	$ 6.00
2½ cu. yds. cinders in place @ $2.00	5.00
¼ cu. yd. sand cushion @ $3.00	.75
Vitrified blocks in place @ $80.00	.75
1 tie rod in place @ $2.00	2.00
7 lin. ft. curb in place @ $1.50	10.50
	$40.25
10% contingencies and overhead	4.03
Total	$44.28
Per square foot	$1.054

CINDER PLATFORM.

Specifications—18 in. cinders, curb 6 in. x 12 in. yellow pine, second hand, bolted to 7 in. x 9 in. creosoted oak posts 3 ft. 6 in. deep placed 4 foot centers.

Cost of 1 ft. section of 12 ft. platform—

1 cu. yd. excavation and disposal @ $2.00	$ 2.00
0.7 cu. yd. cinders in place @ $2.00	1.40
2 lin. ft. curb in place @ $0.37	.74
	$4.14
10% contingencies and overhead	.41
Total	$ 4.55
Per square foot	$ 0.38

GRANOLITHIC PLATFORM

Specifications—1 in. finish, 4 in. concrete, 18 in. cinders and concrete curb.

Cost of 1 ft. section of 12 ft. platform—

1 cu. yd. excavation and disposal @ $2.00	$ 2.00
1 cu. yd. cinders in place @ $2.00	2.00
¼ cu. yd. concrete in place @ $20.00	5.00
2 lin. ft. concrete curb @ $1.00	2.00
12 sq. ft. 1 in. finish @ $0.15	1.80
	$12.80
10% contingencies and overhead	1.28
Total	$14.08
Per square foot	$ 1.17

SCREENINGS PLATFORM

Specifications—6 in. screenings, 18 in. cinders and wood curb.

Cost of 1 ft. section of 12 ft. platform—

1 cu. yd. excavation and disposal @ $2.00	$2.00
1 cu. yd. cinders in place @ $2.00	2.00
0.237 cu. yd. screenings in place @ $3.25	.77
2 lin. ft. curb in place @ $0.37	.74
	$ 5.51
10% contingencies and overhead	.55
Total	$ 6.06
Per square foot	$0.505

WOODEN PLATFORM

Specifications—2 in. x 5 in. yellow pine decking S2S; 4 in. x 6 in. yellow pine girders, 6 in. x 8 in. yellow pine sills, 6 in. x 6 in. yellow pine posts on stone blocking.

Cost of 4 ft. section of 12 ft. platform—

Preparation of site	$ 4.00
[illegible] ft. B. M. 4 in. x 6 in. yellow pine @ $[illegible]	$ 6.53
[illegible] ft. B. M. 6 in. x 8 in. yellow pine @ $[illegible]	5.71
[illegible] ft. B. M. 2 in. x 5 in. yellow pine @ $[illegible]	10.12
2 stone blocks @ $1.00	2.00
	$28.36
10% contingencies and overhead	2.84
Total	$31.20
Per square foot	$ 0.65

CONCRETE PLATFORM

Specifications—4 in. concrete, 18 in. cinders, concrete headers and curb.

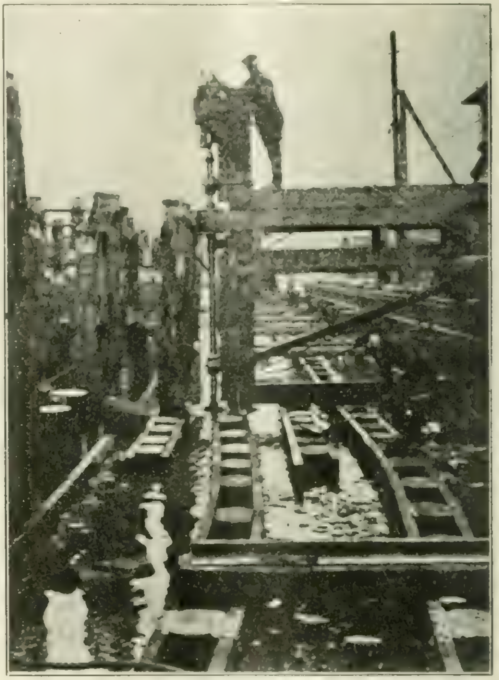
Cost of 1 ft. section of 12 ft. platform—

1 cu. yd. excavation and disposal @ $2.00	$ 2.00
1 cu. yd. cinders in place @ $2.00	2.00
0.2 cu. yd. concrete in place @ $20.00	4.00
12 sq. ft. finish @ $0.05	.60
2 lin. ft. curb @ $1.00	2.00
	$10.60
10% contingencies and overhead	1.06
Total	$11.66
Per square foot	$ 0.97

Saw Rig for Cutting Off Pile Heads

A saw which cuts piles irrespective of the state of the tide has been devised by the Frederick Snare Corporation and is in use on pier job at Philadelphia. This job includes the driving and sawing off of about 7,600 piles. We are indebted to Successful Methods for the following particulars regarding the saw rig:

The rig consists of a 48 in. circular saw attached to the bottom of a shaft which is operated by a 35-H. P. motor. A "bridge," which runs the entire width of the pier (185 ft.) is mounted on seven trucks and is propelled over rails by means of an engine driven by compressed air. The bridge carries two 14-in. I-beams which serve as rails on which the saw rig may travel sideways.



Saw Rig for Cutting Off Pile Heads.

Before sawing the piles, 3 by 12 timbers, which are part of the permanent deck, are bolted to each pile at the proper elevation for cut off. The saw is then run up and placed on these timbers as a guide and the piles sawed off. By means of a screw I-bolt on the top of the saw shaft a man is enabled to keep the saw always in adjustment, so that the cut-off is made sufficiently true for the timber caps.

The pier is 185 ft. wide by 550 ft. long. The piles vary in length from 40 ft. to 75 ft. and are driven by two floating pile drivers. The piles are on 4 ft. centers except at column bases, where they are spaced 2 ft. 6 in.

The saw will cut off a bent of 225 piles in three hours at low tide. The idea of the saw was to cut the piles off under water, and while this operation has been done satisfactorily, the progress made with the saw and the pile driving has been such that the cutting off of the piles is only done when the cut-off is above water. The saw is water cooled by a man with a shovel who also frees the pile heads. After they are sawed off the pile heads are sawed into lumber.

Methods of Jetting Piles

In general, the method of driving piles by using a water jet as an auxiliary has been found to be very successful. It is especially useful in marine driving, or in any location where the piles are driven in the water. Some interesting information on jetting piles was given by Mr. R. C. Young, in an appendix to a committee report presented at the last annual convention of the American Railway Bridge and Building Association. The notes following are taken from Mr. Young's report:

This method of driving piles is more successful in sandy material, although it can be used where considerable clay seal is present. It is also by far the best method of putting down sheet piles in the water. The outfit to be used should be mounted upon a scow of suitable size, having a pump capable of delivering at least 400 gal. of water per minute. The jet should be made of 2½-in. pipe, long enough to reach the bottom of the longest pile. It should have a nozzle of about 1¼-in. in diameter, although good jetting can be done in sand to a depth of 20 ft. with a nozzle as small as ⅞-in., using a correspondingly smaller pump, provided the larger sized pump is not available. This machine should be equipped with drums or winches enough to operate the hammer line, pile line and jet line at the same time. It should also be equipped with one steam capstan on each side of the scow to insure quick moving. This machine should be able to drive an average of 10 piles, 30 ft. to 45 ft. long, per hour with a peneration of 15 ft. to 30 ft. in sand.

The following is a description of an apparatus used by the Lake Superior and Ishpeming for dredging, driving piles, pulling piles and other miscellaneous work in the harbor. In the spring of 1918 this road built two scows from timber resawed from an old dismantled wooden ore dock, at a total cost of $3,130. One scow was designed to carry an "American ditcher." It is 22 ft. 6 in. wide, by 50 ft. long and 6 ft. 6 in. deep. The other scow is a dump scow 16 ft. 6 in. wide by 30 ft. long and 5 ft. 9 in. deep, with a capacity of 30 cu. yd. of earth. It was made light so it could be towed by an ordinary fishing launch, propelled by a 10 hp. to 15 hp. gasoline engine.

The outfit is capable of handling about 300 cu. yd. on a half mile haul in an 8-hour day, with 4 men. If a much longer haul is necessary, two dump scows will be needed. This apparatus is very convenient in picking up shoal spots around a harbor, because it will work to the full depth close to the dock fenders, which cannot be done with a dipper dredge, and because it will move the material at a less price per yard in cleaning up shoal spots and is always available when needed.

Early in 1921 the Lake Superior & Ishpeming was obliged to drive three 30-pile clumps of protection piles at the end of its concrete ore dock. These piles were Oregon fir, 50 ft. long with 10 in. top and were driven in 22 ft. of water, 19 ft. into the sand bottom. The American ditcher was mounted upon the scow, which was fitted with 32-ft. rigid leads attached to the end of the boom. A 2,200-lb. drop hammer and follower was used.

A 6-in. by 8-in. duplex pump was installed. The pump was rather small, but the boiler would not furnish steam for a much larger pump. The jet pipe was 2 in. in diameter and 40 ft. long, with a ⅞-in. nozzle which was as large as the pump would furnish water for. A small gasoline hoist was installed on the scow to furnish power to handle the water jet. This rig was operated by a crew of 8 men and should be able to drive an average of 6 piles an hour in ordinary work.

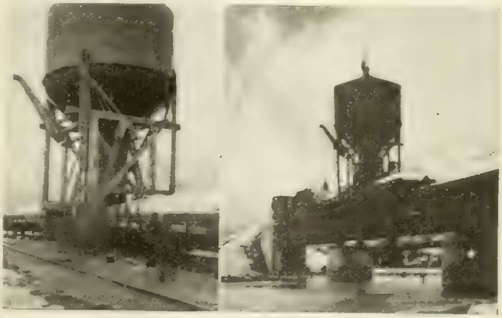
In driving these clumps only 4 piles an hour were driven, the delay being caused by the difficulty in getting the piles close enough together. After this work was finished the crew started to pull the old piles from ore dock No. 1. These piles were 45 ft. long, cut off 1 ft. above the water and penetrated 25 ft. into the ground. There was some clay mixed with the sand bottom at this point and it was found that the pump did not have quite capacity enough to do the work economically, only 2 to 4 piles an hour being pulled, but later, where the piles were 35 to 40 ft. long, the outfit was able to average about 7 piles an hour. The scow was rigged up with two single blocks, so that a pulling strain of about 30 tons could be given to the pile while jetting. Five men were employed in pulling piles. The timber recovered is Norway pine and perfectly sound. A part of it was sold to the mines for trestle legs and the balance will be sawed into flat car decking with a portable sawmill. The work was in charge of August Anderson, a member of this Association.

How a Steel Water Tank Was Moved Two Miles Without Being Dismantled

A 40,000-gal. conical-bottom Horton tank of the Canadian Northern Rys., located for a number of years at Resplendent, B. C., was moved recently a distance of two miles by an unusual method which proved entirely successful.

The method used was as follows. Two steel flat cars were first heavily loaded with ballast, and spurred out, one on each side of the tank, until the draw bars were just clear of the riser pipe. The tank was then jacked up about 20 in., enough to allow the track to be connected under the riser pipe, and also to give sufficient clearance between the same and the top of the rail.

Two timber bents were erected, one on each end of the flat cars, just inside the columns, and the whole structure was supported on these two bents which were tied together at the top with two 8 in. x 8 in. timbers, notched over the caps and bolted one on each side of the tank bottom. The weight was distributed on the bents by placing four short posts on top of the bents just back of the columns, the top ends of these posts wedging against the bottom of the tank. The bents were well sway braced in both directions and were bolstered on the cars with a 2 in. pin through the center, in order that the cars might be free to swing when going around curves.



Moving 40,000-Gal. Steel Tank on Flat Cars.

The cars were then coupled with chains and turnbuckles, one on each side of the riser pipe, the turnbuckles being used to adjust the chains going around curves. A floor of 3 in. planks was laid in the bottom of the riser pipe and about 3½ yd. of gravel were deposited in the heating chamber to act as ballast. Four sets of rope falls were used for guy lines extending from the top of the columns to the sides of the flat cars, there were fastened about 15 ft. from the end of the cars, in order that they would guy the tank in both directions, and in consequence of this we did not experience the slightest difficulty in negotiating two 6 degree curves.

On reaching the destination, the cars were again spurred out directly over the new foundation, and the tank jacked down into place. The actual time that the main line was occupied was 2 hours and 40 minutes, and no delay was caused to trains. In addition to this, the tank showed no signs of being damaged in any manner.

We are indebted to The Water Tower, a publication of the Chicago Bridge & Iron Works, for the above information and illustration.

Increased Demand for Timber Production.—A report of the Service Bureau of the American Wood Preservers' Association shows that over 2,400,000,000 board feet of timber for various purposes was pressure heated in 1921 by the 122 wood preserving plants in operation throughout the United States, thereby surpassing the 1920 record by nearly 17 per cent.

The Engineers and Railroad Transportation*

By HOWARD ELLIOTT,

Chairman Executive Committee, Northern Pacific Ry.

Economies in Transportation.—Improvements in transportation practice have been continuous for a long term of years, and the total accomplished is likely to be lost sight of. Not so many years ago, all the land transportation in the country was furnished by packing on the backs of men or animals; today there are being handled with the aid of less than 2,000,000 men more than 400,000,000,000 ton-miles of freight each year. The physical effort to do this represents, under the old methods, the labor of about 125,000,000 men, and the cost to the public has decreased from $3 to about 1¼ cents per ton mile, based on 1921 returns.

Of course, it would be impossible to apply this amount of man power, but the comparison is given to show how the efficiency of the railroads has released untold man power for the great development of the country in many other directions. It may be argued that highway transportation would have developed even more than it has if the railroads had not been here and the country, therefore, served by highways and waterways. Without the railroads—the primary form of transportation in the country—the motor vehicle, the gasoline to propel it, and the hard surfaced roads never could have been developed except to a limited extent.

Every progressive railroad manager knows that some further economies are possible, but they depend largely on two factors that cannot be made effective at once: First, the spending of money for capital account in the creation of better facilities; and, second, the actual price paid to the individual workman and the development in him of a spirit that it is his duty, as an American citizen, to do all he can to bring down the cost of transportation, because of the help such reduction will be in working out the soundest possible general economic scheme for the whole country. This same idea ought to be applied to those who work in mines, factories and forests, because fuel and material prices affect all and very largely depend on the efficiency of the individual man and the wage paid.

The engineer is peculiarly in a position with his trained and accurate mind to help in determining the wisest form of improvements in transportation facilities and practices to be made (if and when money can be obtained) for increasing economies of operation. Among economies that are not completely developed are:

1. Further decrease in the physical resistance to be overcome so as to lessen the tractive power necessary to haul a ton of freight.

2. Improved location and design of terminals both for handling carloads and merchandise; improved water and fuel stations.

3. Great economies in the production and use of power from steam and electricity, whether obtained from fuel or water power.

4. Improved design of locomotives and cars so as to have the maximum of capacity and strength with a minimum of dead weight.

5. A better supply of well-designed repair plants equipped with high-powered and rapid-working tools in all shops and roundhouses, where mechanical work is performed.

6. Improved methods of receiving, storing and distributing the great quantities of materials and supplies that are used each day by the railroads.

7. The elimination of waste which is prevalent in all walks of American life.

The Future.—It is not beyond belief that within 50 years there will be 250,000,000 people in the United States. They can be well cared for if every one will co-operate and work. Vital to their well-being, however, will be an adequate transportation machine. Today, the country has one made up of the railroads, seaways, waterways, highways, and motor transport, representing great values, possibly $60,000,000,000, or next to agriculture as an element of national wealth. Of this the present railroad system, on any fair basis of allowance for good will, strategic position, experienced organization, and all the elements that enter into values of other classes of property, is probably worth $25,000,000,000. When there are 250,000,000 people, a ton-mileage of even 3,000 per annum instead of the present 4,000, to give them as good a living as is being furnished today, will mean the movement of 750,000,000,000 ton-miles per year plus the added passenger travel—double that now provided.

Thus, the present great transportation machine must be enormously added to, possibly doubled, not in mileage, but in capacity and co-ordinated with other forms of transportation. Great sums of new capital must be obtained, probably more than $25,000,000,000 and this can only be obtained if there is safety for the principal and a fair annual return. The engineer is particularly interested in having this work go on, because of the important part he will play in it, as well as in the development of economies in the existing system.

The country and the world are somewhat in the "dumps," but times will change and conditions will be better. The writer believes that the United States is on the threshold of the most glorious period in its history, and that Americans can take a place in the history of nations never before achieved if they will only think right, work hard, and use carefully their great powers and resources; and the transportation machine should at all times be kept adequate to the growing needs of the country.

The Engineer and Social Progress.—The railroad system of the country has been and is a great engine for advancing civilization. The engineer has played a most important part in creating and operating this engine. With the great development in the United States, however, and the crowding of people into cities, have come perplexing social problems which must be attacked and solved if the country is to achieve its highest destiny. Some of these are:

(a).—Better Use and Conservation of Natural Forces and Resources.—Nature has been generous to the United States and the people have not been obliged to save in the past as much as they must in the future. The engineer, by perfecting the processes for developing and conserving resources can help to bring about better living conditions and promote national health and national safety. Think of the possible development in the next fifty years along the lines of fuel conservation, use of cheaper forms of coal for power, water-power development, control of the flood waters in valleys and control of water in the mountains for irrigation. The better use of natural forces and the elimination of waste in use of natural resources are most important.

(b).—Decentralization of Population.—In 1880, 14,358,167 people lived in cities and towns and 35,797,616 in the country. In 1920, this had changed to 54,304,603 for cities and towns and 51,406,017 in the country.

Cheaper fuels and wider distribution of power will permit a wider use of mechanical devices on the farm, in the small home, and in the small factory, and by increasing comfort and convenience in the country, check the drift to the city.

(c).—Better Rewards for the Farmer.—The cost of living can be reduced if there is a national policy leading to the better use of resources, and more people willing to produce food.

Agricultural and farm life, however, must offer attractions and rewards to the young people equal to what they think can be obtained in the cities.

(d).—The Relation of Labor and Capital.—The distribution of the annual increment of wealth in the country very properly is a subject that engages the attention of every one. Each one naturally desires to obtain all he can consistent with regard to others. Out of this natural effort great organizations of labor and of capital have developed. Such organizations are all right if wisely and honestly directed. Labor unions are all right when they are so conducted that waste is eliminated and they are an efficient and economical instrument of society as a whole. When they cease to be that, their usefulness is gone and society will get rid of them. There is a place in this country for wisely directed labor unions, but no place for labor tyranny.

Society some time ago discarded the club, the sword, and the pistol as weapons for the settlement of personal disputes. Society is getting ready to discard the strike as a weapon for settling industrial disputes, because it is inhuman and uneconomical, the sooner the better for the good of all.

The Engineer as a Maker of Public Opinion.—The engineer is of great importance because of his technical knowledge and trained mind. He is of almost greater importance, however, as a citizen, because he has been trained to be accurate in thought, his calculations must check out, or he fails. He can be of great value in working out some of these social problems, and he can and should counteract the loose thinking and talking that is more or less prevalent, resulting in the advocacy in legislative halls, on the stumps, and in parlors, of foolish doctrines that never have worked and never will.

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*From an address presented Jan. 18, before the American Society of Civil Engineers, Symposium on Railroad Transportation.

The majority of people in the United States, as individuals, are sensible, hard-working, and home-loving; but, collectively, they are sometimes led astray through lack of accurate information and clear thinking. The World War developed a spirit of extravagance and unrest, and there is a noisy minority doing a great deal of talking and advocating what, for want of better names, are known as Radicalism, Socialism, Bolshevism and the use of remedies that may do more harm than good. The engineer, as a citizen, can use his trained mind to help prevent the theorists and adventurers from leading the country astray so that we may jump out of the "frying-pan" of admittedly difficult conditions into the "fire" of much worse ones.

The engineer, accustomed to basing conclusions on accurate facts, can help create a public opinion: That an adequate transportation machine is a necessity; that it cannot be had without paying for it; that the present railroad system was developed by giving the initiative of the American man some chance to work and to obtain rewards; and that better results can be obtained in the future if that initiative is allowed once more to be used without all the hampering and restrictive laws of nation and states that have been put on the statute books in the last 25 years.

Railroads are common carriers of people and property; they are not common carriers of all the economic troubles of the country. These cannot be cured by reducing rates, by ruining the railroads, and perhaps forcing Government ownership to which this country is opposed. Give brains, courage, and management a chance once more. Declare a 10-year holiday in the ceaseless investigation of the transportation question, and let the undivided attention and energy of owners, managers and employees be devoted to maintaining, operating and perfecting this engine of civilization—the wonderful railroad system of the United States.

The Engineer as a Salesman

The engineer is making good as a salesman, according to The Industrial Digest, which quotes George B. Pegram, Dean of the Engineering Schools of Columbia University, as follows:

"From conversations with employers, and from a general discussion of the subject, I am convinced that there is a greater demand now than formerly for men with engineering training in the sales department. I have no statistics upon which to base this opinion, but I believe it to be true. Business has developed in such a manner that technical training is absolutely necessary to a man who wants to sell certain kinds of goods.

"For instance, it is hard to see how the General Electric Co. could sell its goods at all without the aid of men with technical knowledge. The same is true of all concerns which deal in machinery. A man buys a machine because he thinks it will be the most economical means of obtaining the results he wants. Since the determination of the most economical methods of obtaining a given result is an engineering problem, it is natural that engineers are well equipped to sell goods that are bought on that basis."

Dean Pegram was asked if he thought that an engineer loses any of his professional standing when he becomes a salesman.

"No. Selling is just as professional as any other branch of engineering," he replied. "Salesmanship is a field in which a man can display all the high qualities of an engineer. A good engineer-salesman will co-operate with his customers and not try to put something over on them. He will sell them the goods they really need, instead of unloading his inferior stocks on them. And, as business is done today, there is room for such a man to succeed."

The best field for the technically trained salesman is, of course, a field in which the product is used by other technical men for technical purposes. An engineer is naturally adapted to sell such things as electrical goods, machinery, chemicals, and steel products. But this new type of salesman is not confined to these lines. He is appearing in all trades: selling stocks, office specialties, and even ladies' waists.

Moving Steam Shovel in Flooded Gravel Pit

A gravel pit on the banks of the Nueces River in Texas which was being worked by a model 80 Marion shovel with 3½-yd. dipper was flooded by high water in the river. As a result the shovel was standing in 3 to 4 ft. of water. How the shovel was moved to the south side of the pit which was somewhat higher is told in the May Excavating Engineer. The machine was, of course, standing on its own independent track sections parallel to the loading track with 25 ft. from the center of the shovel track to the center of the loading track.

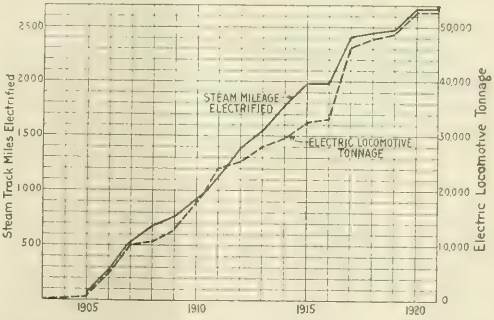
The first move was to disconnect the loading track about 6 ft. behind the shovel. This track was then thrown over and connected with the shovel track. Key ties and rail chairs were used to make the connection with two short pieces of rail cut to the desired length. The first problem was to get the track in line. In order to do this, bars were driven into the ground marking the direction of the track.

The shovel was then moved back slowly under its own power. About 60 ft. had been covered when the rear truck left the rails. The ties at this point were so far apart that one pair of wheels went down between the ties. It was then necessary to lace ties in between the wider spaced ties in order to make a flooring and to bring the wheels up to where a frog could be set. The frogs were then set and spiked down and the shovel re-railed at the first pull. It should be noted that this was all accomplished under water and had to be done entirely by feeling, as the water was very muddy from being stirred up by the men working in it.

After the machine was re-railed it was taken back under its own power a distance of 1,000 ft. through water which in places ran up to 4 ft. in depth, and cut in on dry ground. It is now again in steady operation.

Growth of Heavy Electric Traction

In connection with its report presented at the last annual convention of the American Electric Railway Association, the Committee on Heavy Electric Traction submitted the accompanying chart to show the growth of steam railroad mileage electrified and electrified locomotive tonnage in heavy traction service in the United States and Canada. It will be noted from the diagram that the electrified track mileage and locomotive tonnage has increased at an approximately constant rate from 1905 to the present time, and that in 1921 there was something more than 2,000 miles of electrified track and over 52,000 tons of locomotives in service.



Steam Railroad Mileage Electrified and Electric Locomotive Tonnage.

Progress on Shandoken Tunnel, New York.—During the year, May 1, 1921, to May 1, 1922, the average weekly progress of excavation on the Shandoken tunnel of the Catskill water supply of New York City, was 92.8 ft. The total excavation during the year was 56,052 ft. The tunnel is being driven from 12 headings.

Instruction of Students in the Use of Technical Literature; an Unexploited Phase of Engineering Education*

BY E. H. McCLELLAND
[illegible]

Though the real value of technical literature has never received adequate recognition there is evidence of an increasing interest in the subject. In a recent letter to the editor of Science, it is stated that "in these days of closed doors and crowded hotels the one place where the stranger is sure of a welcome is the public library;" and, continuing more seriously, the same writer says that "The dependence of the present-day investigator upon institutional libraries is almost absolute."

Never in the history of America has there been a time when scientific investigation was pursued so zealously as today. Almost every large manufacturing company is depending to some extent on a Research Department or Department of Technical Control, or whatever it may be called. We hear and read everywhere of research problems and research methods and there is much tangible evidence that research in America is beginning to receive the attention it so richly merits; but any intelligently directed research takes into account first of all the available information on the subject, and no original research can be judiciously conducted until cognizance is taken of the state of the art as recorded in the existing literature. This is pretty generally recognized, even if not universally practiced. But research is only one of the purposes for which contact with technical literature is essential, and modern industrial progress is so rapid that the engineer who fails to keep in touch with the current literature in his field is in danger of falling behind the procession.

It may be assumed, however, that with this audience I need not undertake to establish merits of engineering literature or the importance of using it. These points I think are conceded and we are concerned chiefly with the problem of getting the student—the future engineer—to realize the importance and the potential value of the printed resources at his command today.

In the utilization of technical literature (as in many other things within the student's experience) there is no royal road to proficiency. The way to acquire proficiency in reading a foreign language is to read copiously, and the way to become an expert swimmer, or a crack marksman is to practice faithfully. Swimming and shooting usually require no artificial incentive to practice, but in promoting the study of engineering literature we find an obstacle in the rather anomalous condition that the average student is not easily interested until he has acquired some proficiency; while, on the other hand, he cannot possibly attain proficiency without considerable practice. This means that if the student is to be properly trained in the use of technical literature, the burden of responsibility for this training must be placed on some one else, and the task is not an easy one. It demands one of two things: (1) eternal vigilance in holding the student to an undertaking which he is inclined to consider rather irksome, or (2) considerable ingenuity in developing interesting and attractive features so that the subject may appeal more strongly than it does to the average student today.

Perhaps one reason for the average student's apathetic attitude towards engineering literature, and his failure to grasp its importance, may be found in the fact that usually the work is not dignified by any definite place in the curriculum. When time is given for this work it is frequently in substitution for a class-room or laboratory period—apparently as an afterthought. Until the study of engineering literature is recognized to the extent of being installed in the regular curriculum, so that the student may understand it to be part of his required course and think of it in these terms, there is a sound psychological reason for his regarding it lightly.

Apropos of the apparent dearth of the highest type of scholarly reasearch worker, something has been written to the general effect that many of our technical students are of the active, energetic type, eager for results and attracted by large and spectacular undertakings—students with no intention of plodding and with little patience for great detail, so that they do not readily settle into the restraints of research work. You who are engaged in technical education will, of course, know to what extent this opinion is correct; but I submit the thought that this impetuous type of student will be quite prone to think of work with engineering literature as a mere delving into musty books, and to be characterized as effeminate and enervating. I think his views might be modified if he could visualize technical literature as a live and growing thing, and if he could have some conception of the number of, and the eminence of, some of the successful engineers who today are achieving a large measure of their success through alert and intelligent use of patents, engineering reports, and technical and trade journals. I think he would view the matter from a slightly different angle if he could look through the correspondence files of a large technical library and realize the type of engineer who is demanding help from the available literature. It would help him if he were to ponder a little on the fact that the engineering literature which he may be inclined to despise is the work of notable engineers, just as much as is the bridge or the tunnel which he admires. Pittsburgh is noted for its engineers, and some of our very good books are by Pittsburghers—technical men whom the student in Pittsburgh knows by reputation, at least. Probably not only the student but the average professional engineer in Pittsburgh would be surprised to know to what extent technical literature has been enriched by our local engineers and technical men.

Another probable reason for the indifference of the student is ignorance of method; that is, he may have no knowledge at all of how to use library catalogues and indexes, or of how to use books properly when they are set before him. In his early attempts to use a library, therefore, he will probably fail to find exactly what he wants; but he should not become discouraged and blame the library. No one should expect to turn out perfect work the first time he tries to use drawing instruments or wood-working tools, especially if he be given no instruction regarding the purposes of the various tools, and the best methods of manipulation; but books and indexes are tools, also, and proficiency in their use does not come by intuition. The departments of chemistry in a number of colleges and universtites have given considerable attention to courses in the use of chemical literature; but parallel courses in the use of engineering literature are even more urgently needed, since the literature of chemistry (by reason of its multiplicity of compendious reference works, its various abstracts of comprehensive scope, and its incomparably greater wealth of bibliography in general) is much more readily accessible to the worker than is the literature of engineering.

One way in which students are frequently brought in touch with scientific and technical literature is for the instructor or the librarian to select lists of books on various topics, place these on designated shelves or tables and reserve them for student use during limited periods. This has been done on a rather large scale here in Pittsburgh for 15 years or more; but this is the mere beginning—the very first step, and not a highly important one—in any scheme for imparting to the student any real and lasting knowledge of technical literature. This scheme is admirable for the student's convenience in obtaining information on some one particular subject; but practically valueless for enabling him to obtain information on any other subject. When the volumes are removed at the end of a two-weeks' period, for example, it is extremely doubtful if the average student could reassemble the references by looking up the material for himself. This must not be construed as condemnation of this practice. The procedure is a good one for the purpose which it is primarily designed to serve. It puts the student in touch with a certain amount of selected literature, but it generally fails to aid him in further selection.

The remedy, of course, is to give the student practice in finding his own references, and this means that he must acquire some facility in the use of indexes, catalogues, and bibliographies. Knowledge is of two kinds: that which we have and that which we can find; the latter is almost as usable and its quantity is infinitely greater.

In training students in the effective use of technical literature, responsibility rests mainly with the faculty, and one of the desiderata is that instructors shall have a fair knowledge of library methods and a thorough realization of the importance of citing references with such fullness and accuracy that there may be no difficulty in identifying them. A frequent but disheartening experience in libraries is that of trying to help the inquirer who brings in some such reference as "Government Bulletin 25"—a reference, which, of course, is impossible of identification without a knowledge of the bureau or department which issued it. The avoidance of such ambiguity is highly important when initiating a student into the technique of library methods.

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*[illegible] of Engineering Education.

In some colleges, very good work is done in seminars or assemblies of some sort in which the instructor and the students devote an occasional session to the consideration of technical literature. This has been done most frequently with classes in pure science, but there is a growing tendency to extend the practice to engineering classes. In one western university which for a number of years has featured weekly sessions in a course of this kind, it is said that graduating classes have been unanimously of the opinion that, for the time spent on it, this course exceeds in value anything else in the curriculum. This gives evidence of a most successful course, and doubtless excellent results would be found elsewhere if we were to make a survey of the work done in various institutions.

I have very superficial knowledge of the seminar methods employed in different colleges, but, apparently, attention is given chiefly to new books and to selected lists of current magazines—presumably those selected by instructors. This work is highly commendable, but there seems to be little evidence that it is suplemented by instruction which will enable the student, when thrown on his own resources, (1) to keep informed regarding new books; (2) to pick out those which are of greatest value; (3) to recognize and interpret reference books so as to approach them with some degree of assurance; (4) to select the best magazines in special fields; (5) to survey periodical literature speedily by means of indexes, abstracts, etc.; (6) to make proper use of the constantly increasing mass of official literature, issued by federal and state government agencies—in short, to keep effectively in touch with what a former professor in one of our engineering schools has aptly characterized as "printed engineering resources."*

The young engineer should not only be trained in evaluation of the books to which he has access; he should be instructed as to the sources of information regarding books not available for examination. I know a young mining engineer who ordered, merely from the publisher's announcement, a large and expensive set of volumes which he expected to be of special service to him. On arrival of the books, however, he found that, though concerned with minerals, they were of no direct value to him as they were written wholly from the viewpoint of the chemist. This rather costly experiment in book selection might have been avoided had he consulted the numerous reviews available.

Dependable book reviews constitute the best single source of information regarding the character of new books, and engineers might profitably devote more attention to the reviews in journals covering various branches of engineering. Libraries which are concerned with careful book selection depend to a considerable extent on book reviews, and the Carnegie Library of Pittsburgh has probably gone further than any other library in using and recording these reviews. For many years abstracts of reviews have been filed in a card-index and since 1917 a record of the reviews in numerous scientific and technical journals has been published quarterly under the title "Technical Book Review Index." This Index, which is the only publication in the world devoted to recording reviews of scientific and technical books, includes from 4,000 to 5,000 references annually, and is the most comprehensive existing guide to the evaluation of new technical books.

Modern progress is so rapid, however, that in certain fields books are in some degree obsolete when published; thus the engineer who would keep thoroughly up to date must depend largely on current periodicals and serials. These are now so numerous that the busy engineer cannot afford the time necessary for examining any large part of them at first hand, so he must have recourse to indexes and abstracts. Familiarity with these is probably best acquired through insistence on bibliographic work.

The making of bibliographies is one of the most helpful forms of training; provided that the training be judiciously given. With good library facilities any college student should be able to make a brief and intelligible list of references on any important engineering topic, but it scarcely serves the purpose if he merely copies titles from some index. He should be taught to verify the references, amplify the titles when necessary, and evaluate the articles where possible—in short, to enable the user of his bibliography to determine definitely the scope and nature of each article and whether it will justify the time spent in examination. Reams might be written on bibliographic method, but the last sentence above constitutes the basis of good work.

Going a step beyond bibliography we have abstracting, and students should be taught to abstract, digest, or summarize technical papers. Hundreds of scientists through the United States are regularly examining current literature and preparing digests for various abstract journals. Bibliographies and indexes are the keys to the rich storehouse of technical literature, but abstract journals are the master-keys. Many of the important scientific and technical societies now require every author to submit a satisfactory abstract of his paper, and it is desirable that every engineering student should have some training in this kind of work.

After the student has some conception of the nature of indexes, abstracts, bibliographies, etc., and some operating knowledge of these useful tools, one of the most potent factors in stimulating the study of technical literature, will be a class discussion (quiz, or round table, or whatever it may be called). In this discussion the instructor should verify the students' researches. This need not be a laborious matter. For example, either the instructor or the librarian may refer a student to indexes where he will find references on irrigation, but it remains for the instructor to determine how intelligently these indexes have been used. When the student reports his references, ask where he got them. Probably he will not know. Next time he will probably know that he got them from the "Engineering Index," for example, but he may not know anything about the index or its scope and functions—that it appears monthly, cumulates annually and is a valuable adjunct to the private engineering library.

The student should really be receiving a course in the manipulation of literary tools. It is what may be called an "operating" course, and his output should be judged not alone by the standard of quantity, but should be inspected for quality. For example, if he submits twenty references on a particular subject, it must be determined whether they are accurate and whether they are especially applicable; that is, would they give a practicing engineer helpful information on the subject under consideration. The mass of engineering literature is so enormous that the mere finding of references does not suffice; they must be the best references.

A little insistence on care and observation will go far to enhance the value of the work, and students may soon be brought to see that books may be identified by their authors, titles, publishers, dates and editions; and magazine articles by the titles, dates, volumes and pages of the magazines; and that this indentification may be just as definite and accurate as the botanist's classification of plants. For the student to state that he found his information in a "little, thin, green book" is as ridiculous and unscientific as for an engineer to specify "metal rods about as thick as a man's thumb."

Students will go to the literature if there is sufficient incentive. There is one power-plant in the Pittsburgh district which engineering students are frequently required to visit and describe. An excellent description appears in one of our technical journals, and one copy of this has been cut out and a second one worn to shreds. Fortunately we have been able to secure extra copies and we now try to avoid giving out our bound volumes for this particular problem. The case is mentioned here to show that a student will use the literature if convinced that it will really help him in his required work.

One incentive to study would be to let the student see that this study may be made a revenue producer. It can hardly compete with the war-time possibility of spending a half holiday in some industrial plant and getting paid for it; but the careful student who will acquire the principles of bibliographic work and abstracting should be able to market the product of his spare-time work. It should be possible, for example, to sell today a well-digested summary of the literature on heating furnace design, or the working of steel or electric insulation. In a large industrial region there are likely to be many technical investigations under way and the close contact between institutions and industries today should enable the instructor to give the exceptionally qualified student some suggestion as to problems on which bibliographies might be welcomed.

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*J. Martin Telleen, in Bulletin of the Society for the Promotion of Engineering Education, Nov., 1914, pp. 18-27.

With many students the appeal will be stronger if the assigned problems have a commercial or industrial trend. Set a student to determine what companies build turret lathes, or locomotives; in what part of the country are the plants?; what are some of the largest companies and what is their capitalization? Who is the president or the purchasing agent of each? What journals would offer the most fertile field for advertising their product?, and what kinds of trade literature (catalogues, house-organs, etc.) do they issue? Not all this information can be found readily; that regarding smaller companies is particularly elusive—but the search for information of this nature will properly call into use a set of tools and aids entirely different from those used in obtaining information on engineering or purely scientific topics. This sort of problem in some form comes to libraries almost daily. Very recently a young engineer, whom I had previously known only by mail, spent several hours in the Carnegie Library of Pittsburgh, his purpose being to get information on a large western company which had offered him a position.

A good practical problem would be to have a student imagine himself ordered to a foreign country (remote from libraries and book-stores) under instructions to assemble and take with him a good working library for a chemical laboratory or a civil engineer's office, for example. During the present year we have helped two men in just this emergency, and with little time to act. Books and magazines are coming to be considered among the regular "tools" of an engineering or industrial works, and the engineer of tomorrow who has some knowledge of how to discover and evaluate technical literature is very likely to find that this knowledge constitutes a valuable asset.

With a general class in engineering, it would seem that an interesting session might be held occasionally with nothing but a copy of an engineering or technical index. By merely going over the titles with the students, it is inconceivable that some interest should not be aroused. If desired, an interesting general drill might be developed here. Read the titles of some rather specialized articles and have the students indicate the branches of engineering to which they belong and name journals in which they might logically appear. Have students define any terms not generaly understood. Probably every one will understand "cantilever," but the electrical student may have to define "catenary" for his classmate in the civil course. Probably a number of students will be doubtful about "telpher" and a larger number about "sonims." An occasional "skimming" of one of these current indexes should stimulate knowledge of engineering terminology among students and it may not be bad for the instructor—but the real benefit, of course, will be in giving the student some familiarity with the scope and nature of the indexes; for any course designed to acquaint students with technical literature should be somewhat less concerned with the technical information acquired than with the sources through which it is acquired.

While a really instructive course should be so designed that the work will be based largely on indexes, abstracts, and bibliographies, constant use of these may result in monotony. Much will depend on the personality and resourcefulness of the instructor and on his knowledge of the subject, but there is an infinite variety of problems which may be presented. Regarding books, questions such as the following may be asked:

In what essentials do reference books differ from textbooks? Can you compare (not merely name) three important reference hand-books of civil engineering in use in the United States today? We have no recent textbooks of "civil engineering"—why? In some cases the use of a British book is permissible, in other cases very objectionable—have you any idea of the reasons which govern this? Can you name one American publisher whom you can confidently recommend for (1) textbooks on chemistry, (2) reference books and textbooks on electrical or mechanical engineering, (3) manuals of machine-shop practice, (4) practical manuals on operation of prime movers and accessories? If a new book is handed to you can you tell promptly, (1) whether it is American or British, (2) whether it has appeared in previous editions, and, if so, whether the present edition is probably very different from the preceding? (3) How would you proceed to get a prompt idea of the scope of the book? (4) What is the chief purpose of the index and does it fully serve this purpose? (5) What sources can you suggest in an attempt to find out something about the author? (6) Are the illustrations in the book apparently the best kind for their purpose? (7) If you wanted similar illustrations for an advertising booklet, or for a technical paper which you were offering to a technical journal or presenting before an engineering society, what kind of copy would you have to furnish? Can you suggest some subjects on which illustrations should preferably be in line drawing, and others to which photographic reproductions would be better adapted?

The instructor can supply an unlimited number of questions similar to (or better than) the above, and yet confine his "object lesson" to the general principles which should be observed in any consideration of technical literature. Later on, when the young engineer finds it necessary to consult or purchase engineering books, he will find that some grasp of the rudiments of book evaluation will ably supplement his knowledge of the subject matter of the books.

The few questions above are concerned solely with books, but the practice should be extended to periodical and other literature. The questions will require a little thought and investigation on the part of the student and will necessitate the use of indexes, thus affording some desirable familiarity with these. In this practice work, it should be borne in mind that the student will profit mainly by attention to the method rather than the result. It is less important that he should assimilate the literature available on a problem today than that he should acquire a working knowledge of how best to approach that and other literature in future.

The minimum requirements for the student who expects to do effective research work in technical literature may be briefly summarized as follows:

Books.—An acquaintance with the forms and use of the several types of card catalogues found in public and institutional libraries (thus enabling him to get in touch with all books in the particular library to wihch he has access); supplemented by an acquaintance with such tools as the book publishers' trade lists used by libraries and book dealers (thus enabling him to get in touch with all books published on any subject); and supplemented further by some knowledge of the existence and use of book reviews and other aids in book selection (thus assisting him in evaluation of books to which he may not have access).

Periodical Literature.—An acquaintance with the scope and functions of indexes and abstracts concerned with current technical literature and an actual working knowledge of the more important of these (thus enabling him to get in touch with recent material not yet incorporated in books, as well es an enormous amount of older material); supplemented by an acquaintance with the few existing guides showing what periodicals are published on any subject and where they are published.

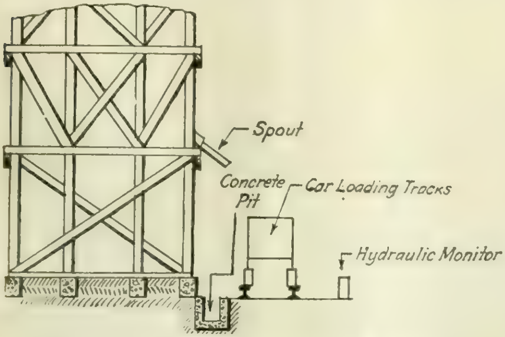
Bibliographies.—A recognition of the value of bibliographies and some knowledge of how to find them (since in many cases he will find that an existing bibliography covers all, or a large part, of his preliminary search by assembling references to the scattered literature in books and magazines).

A student may appear to be making great progress with the literature which the instructor or the librarian selects for him; just as an untrained manual-arts student may get credit for constructing a fine piece of cabinet work, when in reality his instructor may have done much of the responsible work. Either of these students is likely to be less well equipped for future work than the student who has stuck to rudimentary operations and practiced diligently. Regarding the effectiveness of continuously repeated effort, it is well to bear in mind the Englishman's statement—"It isn't the 'eavy 'aulin' as 'urts the 'orses' 'oofs; it's the 'ammer, 'ammer, 'ammer on the 'ard 'ighway."

Method of Keeping Railroad Tracks Clean at Sand Loading Plant

Derailment of cars due to sand spilling over the loading tracks in sand and gravel operations is not uncommon. An inexpensive method for keeping tracks clean, used at the plant of the Flint Crushed Gravel Co., Des Moines, Ia., is described as follows by Rock Products:

On either loading side of the plant is a narrow concrete runway which drains into the waste water pond and also a hydraulic monitor. As a car of sand is loaded and gravitated to the storage yard the attendant flushes the tracks clear with water from the monitor. The water and sand run into the concrete runway and thence to the waste water pond. This method keeps the loading tracks clear at all times and prevents derailment due to sand lodging on the tracks.



Concrete Runway, Loading Tracks and Monitor.

New Subways to Cost $218,000,000 Proposed for New York City

The Transit Commission of New York City, on May 11, announced a construction program calling for the building of 32½ miles of new subways at an estimated cost of $218,000,000. Equipment for the operation of these lines is estimated at $100,000,000 more. Seven new routes are proposed; listed in the order which the Commission believes they should be put under construction, they are as follows:

I. The extension of the Corona line, in North Queens, from Corona to Flushing; estimated cost, $2,800,000.

II. The extension of the crosstown subway in Forty-Second street, Manhattan, with moving platform equipment connecting with each of the present and future north and south rapid transit lines, both subway and elevated; estimated cost, $6,000,000.

III. A Staten Island Tunnel, to connect with the Fourth Avenue subway, in Brooklyn, and with the various steam and trolley lines in Staten Island; estimated cost, $17,000,000.

IV. An extension of the Broadway-Seventh Avenue line of the Brooklyn Rapid Transit system, from Fifty-ninth street, Manhattan, under Central Park West, 110th street, and Seventh avenue to 155th street; estimated cost, $26,500,000.

V. A Brooklyn crosstown line from the Queensborough Plaza in Long Island City to a point of connection with the Brighton Beach line, at or near Franklin avenue and Fulton street, Brooklyn; estimated cost, $24,000,000.

VI. A new subway and East River tunnel to connect the Fulton Street elevated line, in Brooklyn, with the Broadway-Fourth avenue line at the City Hall station in Manhattan; estimated cost, $28,000,000.

VII. A new trunk line subway to run from downtown Manhattan to Washington Heights, following, in the main, Eighth and Amsterdam avenues; estimated cost, $69,500,000.

The several new routes projected will add the following track and route mileage to the present mileage of the dual system:

No.	Classification.	Length of Route in Miles.	Length of Tracks in Miles.
1.	Flushing Extension	1.90	5.20
2.	Forty-second Street Moving Platform Line.	2.00	4.00
3.	Staten Island Tunnel, either alternative..	3.20	6.40
4.	Central Park West-Seventh Ave. Extension	5.40	[illegible]
5.	Brooklyn Crosstown Line	6.25	12.50
6.	Fulton Street Elevated Extension	2.80	7.60
7.	Eighth Avenue-Amsterdam Ave. Line	11.00	38.00
	Total	32.55	84.20

The total estimated cost of the construction of the seven projects in view is in round numbers $174,000,000. With the addition to this figure of the overhead costs of administration and engineering, and the amounts of interest on the funds employed, paid during construction, estimated at $44,000,000 in all, the total cost of the lines will be $218,000,000.

How to Socket Wire Rope

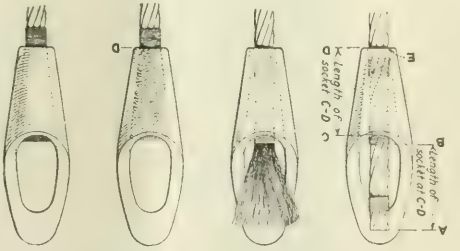
Useful instructions for preparing the socket attachment for wire rope were given by Donald J. Baker in a recent issue of Coal Age. Proceeding in accordance with them, according to Mr. Baker, permits of the rope being used to a full 100 per cent of its capacity, instead of only 70 per cent, the figure that has long been accepted as safe where the strands are bent back on the socket and babbitt metal used as the filler. The four stages in socketing the wire rope are shown in the accompanying illustration.

Three seizings are put on the rope. The socket is carefully cleansed of paint and grease and rounded out smoothly at E. The rope is then passed into the socket as indicated at left. The end seizing is then removed; the wires are untwisted until they stand out like a broom, as in the second view, and the hemp core is cut as far as the second seizing. The wires are then thoroughly cleansed with gasoline and with hydrochloric acid. The rope is then drawn back as shown, and pure zinc at the proper temperature is poured in and allowed to set. Then the two remaining seizings are removed.

It is far better and much more economical in the long run, states Mr. Baker, to employ in the beginning a steel rope that is from 25 to 50 ft. longer than actual initial requirements. Yet it is not uncommon to see the drums of hoisting engines entirely bare when the rope is paid out.

Stresses sustained in heavy and continuous hoisting, while having their effects on all sections of the rope, are more noticeable in certain places than others. That portion of rope adjacent to the socket, as well as that near or in contact with the shaft side of the sheave wheel when the load is at rest at the bottom, are subjected to more wear than is the rest of the cable. When the load or skip comes to rest at the bottom of the shaft, the rope is continually vibrating. The extremity or point of this vibration ends at the sheave wheel at the top and at the socket on the load itself.

This is more wearing on the rope than the actual hoisting cycle. Not only is there a tendency on the part of the cable to stretch throughout its entire length at such times, but shearing forces are exerted on the strands at the socket. It is considered wise, therefore, to cut off and scrap, every six months or a year, 6 ft. or so of the rope nearest to the socket. The section nearest the sheave wheel will thus be lowered away from the point of undue stress, and consequently will not be subjected to any forces other than those exerted in a straight pull. It is always well to provide a drum that can carry the extra length of rope; otherwise in a few months it may be necessary to scrap the whole rope as too short for the service, as a result of having become worn out at its lower extremity.



Four Stages in Socketing Wire Rope.

Converting Steam Lines Into Light Electric Railways

Trunk line electrification of railroads is no longer a question of engineering but strictly one of finance. The economy of main line electrification under certain conditions is recognized at least by those who are fully informed. The problem is how to undertake the herculean task of raising funds for electrification even in the certainty that the change can save money.

The Chicago, Milwaukee & St. Paul electrification, a very fine job from the engineering standpoint, ran toward $50,000 a mile without the development of power or the building of power houses, the energy being purchased. Had these other items entered, the cost would have gone above the figure just mentioned. When one realizes that some of the long Western lines were originally built and equipped completely for a figure no greater, it is self-evident that the chance for rapid development of electric service is very small until the railroads shall have recovered enough from the desperate condition into which government mismanagement plunged them to take advantage of the opportunities for improvement that electrification offers.

With reasonably heavy traffic there is no doubt as to the issue. So long as traffic is light, however, the odds are against success unless the situation is squarely met by adopting some such method as the light electric railway—that is, converting an ordinary railroad into a system resembling the less heavily equipped interurban systems. This step might now and then be a very useful and profitable one, but on the whole the tendency in this country has been, perhaps unwisely, directly against what are known elsewhere in the world as light railways.—Editorial in Electrical World.

Management—An Opportunity for the Engineer*

It is not that the engineer is unwelcome in that wider field. To quote our banker once more—bankers as financial godfathers of enterprise, "yearn for a sure thing and welcome the engineer with his mathematical accuracy" in corporation management, but with his "natural handicap" increased by present methods of training he has proved a disappointment and a failure as a manager; and if he would occupy such positions with success his education and training must be profoundly modified." A statement having the same significance is attributed to the Professor Hugo Munsterberg: "We live in the day of the scientist and the expert, and he who closes his ears to their advice will never dig the first potatoes from his acre." To realize further that there is not only a welcome but a positive need in that field we have only to refer to the recent report of the Federated Engineering Societies' Committee on Elimination of Waste in Industry where we discover that more than 50 per cent of the responsibility for waste is with management, and less than 25 per cent with labor. In other words those who now plan and direct the industries with their myriad combinations of labor, materials, and appliances must be held more to blame for the shortcomings than all other elements in industry combined. Does this seem hardly less condemnation of the non-technical management than that of the technical, already quoted? The more evident, then, is the need and the opportunity for the engineer. Finally, our most recent editorial plaint warns us that "the most profound need of American business today is for men of trained imagination to guide technical processes and mechanical practices on their human side to effective conclusion."

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*From an article, "The Humanism of Engineering," by Ralph R. Tinkham, in The Michigan Technic.

The Engineer Has Failed to Reach the Public*

Be that as it may, the fact remains that public opinion, itself a prime all pervading force of nature, is slow to change its course. The situation parallels the familiar case of the double column front page headline retracted later in a three line paragraph set between the ads on the seventh page. Mark the amazing admission made by a former Mayor of Detroit not many years ago at a banquet of the Detroit Engineering Society. It was a large assembly and included in its number several distinguished gentlemen widely and favorably known in our profession, whose polished remarks reflected a degree of culture too seldom emulated by our rank and file. His Honor arose after a sparkling introduction and expressed himself first as greatly surprised at the character of the gathering, because, as he explained, when he had accepted the invitation to the banquet of the "Engineering Society," he supposed we were the men who stoked the fires of the heating plants in the school buildings and city hall!

One more incident will illustrate a phase of the professional failing. Only recently the writer was present at a crowded meeting of a state engineering society. The speaker, an engineer and a member of the society was also a successful and well known business man. His subject was one of vital interest to the metropolitan community in which we met, and related to a public utilities problem involving possible savings to the citizens of hundreds of thousands of dollars. The speaker even made special appeal for the dissemination of the data which he had collected at considerable expenditure of time and labor. While this has doubtless been done to a strictly limited extent by the comparative few then present, yet the newspapers, of which there are several, had little if anything to say regarding the meeting, and no editorial comment whatever. The conclusion is obvious. The engineer fails to reach the public.

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*From an article, "The Humanism of Engineering," by Ralph R. Tinkham, in The Michigan Technic.

Personals

Harry W. Phillips has been appointed superintendent of construction for the city of Davenport, Ia.

E. O. Shyrock, Superintendent of Railways for the Northwestern Ohio Ry., has resigned and has become superintendent of the Columbus, Newark & Zanesville branch of the Ohio Electric Ry.

Thos. Taylor, for the past [illegible] years designing and constructing engineer for the Department of Works of Toronto, Ont., has been promoted to the position of engineer of railways and bridges of that department.

George Lewis, a contractor at Denver, Colo., has been appointed assistant to William F. Robinson, president of the Moffat Tunnel Commission, which will construct a 6-mile tunnel through the Continental Divide.

William F. Strouse has resigned as chief engineer of the Public Service Commission of Maryland and will be succeeded by H. Carl Wolt, now engineer of public utilities for the commission. Mr. Strouse, as valuation engineer, will continue to be a member of the commission's engineering staff. Mr. Strouse retires from his former position at his own request. In a letter to William M. Maloy, chairman of the commission, Mr. Strouse said he felt that his duties as chief engineer, which involved much detail work, had prevented him from working along lines in which he was especially interested and along which he felt much work ought to be done. In his new field he will take up matters pertaining to valuation, cost analysis and the like of the various utilities of the State.

Major L. D. Blauvelt has resigned as state highway engineer of Colorado, to become chief construction engineer for the Moffat Tunnel Commission, Denver, Colo., which will construct a 6-mile railroad tunnel through the Continental Divide. Major Blauvelt was formerly chief engineer of the Denver & Salt Lake R. R. He came to Colorado from New York in 1889, following his graduation from Rutgers College in New Jersey. In Colorado he became identified with the old Colorado Midland Railroad and was one of the builders of that pioneer line. Later he located the Cripple Creek Short Line R. R. and was one of the engineers in charge of its construction. He engaged in mining in the early days at Cripple Creek and in 1902 became a locating engineer for the Denver & Salt Lake R. R. In [illegible] he became chief engineer for that road and directed the construction of five miles of tunnel on that line.

Obituaries

George B. Boggs, a former chief engineer of the Philadelphia & Reading Ry., died recently at Towanda, Pa., aged 78.

James C. Dunn of the Dunn & McCarthy Construction Co., Railroad Contractors, Chicago, died June 9, at his home in Chicago after a long illness. In addition to being one of the leading contractors of the country, Mr. Dunn was president and chief owner of the Cleveland American League baseball team.

Ignatius M. De Varona, who retired eight years ago as chief engineer of the Department of Water Supply, Gas and Electricity of New York City, after thirty years in the service of the city, died on May 12 at his home in New York.

He was born in Cuba in 1842, graduated from the Rensselaer Polytechnic Institute in 1863 and in 1882 began the extension of the Brooklyn water works. In 1904 he installed a high-pressure fire system in Brooklyn and followed it with a similar system in Manhattan. In 1910 he was made chief engineer for the Greater City. He prepared the plans for the utilization of the Catskill water supply for the five boroughs and for the tunnel under the Harlem River.

Industrial Notes

The Pittsburgh Testing Laboratory has appointed Harry M. Wey manager for the Chicago District with offices at 1560 Monadnock Block, Chicago.

Orton & Steinbrenner Co., manufacturers of locomotive cranes, grab buckets and coal crushers, in order to secure larger space have moved its offices from the 11th to the 19th floor of the Transportation Bldg., 608 So. Dearborn St., Chicago, Ill.

R. M. McCrone of Bangkok, Siam, visited Omaha recently and placed an order with Stroud & Co. of Omaha for three elevating graders to be shipped immediately to Siam. These American graders will be used on a large government railroad and irrigation project in Siam.

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Are the peak of efficiency in taking out foul air, gas, and smoke. They are the ideal industrial ventilator. Revolve on greased ball bearings that are entirely enclosed and weather protected. No back draft.

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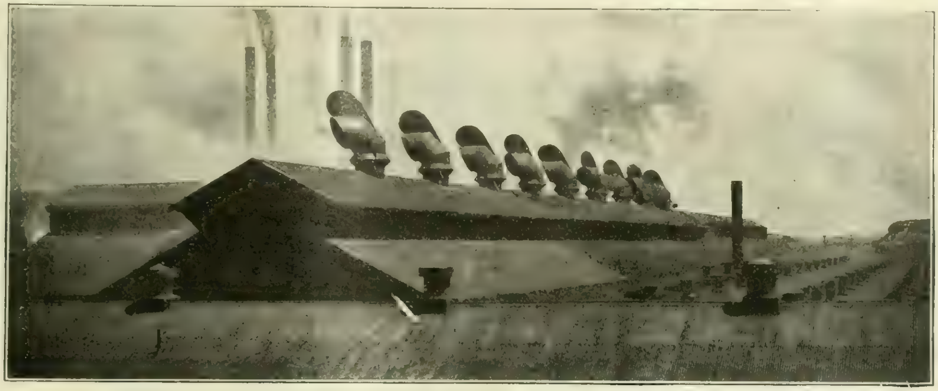
"Are Quite Satisfied and—"

The Milwaukee Corrugating Co., [illegible] 24, 192[illegible]
Milwaukee, Wis.

Gentlemen:

We have at this plant [illegible] galvanizing department one of your Alpina V[illegible] connection with an extensive ventilating [illegible]. These ventilators are subject to corrosive fumes [illegible] installed several months ago. They run [illegible] very sensitive to wind direction. W[illegible] with this installation and can cord[illegible] ventilators for similar service.

With our kindest regards, we [illegible] remain
Very truly yours,
The Canton Sheet Steel Co.
Chas. W. [illegible], General Manager



Showing the Battery of Alpina Ventilators at the Plant of the Canton Sheet Steel Company

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Reinforcing Steel

Round and Square, Plain and Deformed Bars. Bent to shape required, bundled and tagged ready to be set in the forms. Lump sum estimates from your plans.

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Concrete
Reinforcing Dept. E

JOSEPH T. RYERSON & SON
CHICAGO, ILL.
ST. LOUIS DETROIT BUFFALO NEW YORK

From the Publisher's Point of View

"The Unforgiving Minute"

Have you ever noticed that in voluntary committee work, such as the committees of professional and business associations, and committees that really get things done, are those composed of the men who are busiest **outside of such committee work?**

The really busiest men always have time to do the things that they conceive to be "up to them" to do.

You will hear men say that they "haven't time" to do important committee work—to attend meetings of their business or professional associations—or to read.

These men have not learned to utilize minutes.

One of the many amazing things about Theodore Roosevelt was the breadth and amount of his reading. He always had reading material at hand. Much of his reading was done in little stretches of five and ten minutes. In little gaps between other activities.

You will find that the really busy and successful engineer knows what is in the worth while journals of his profession.

He makes full use of "the unforgiving minute."

Engineering and Contracting

SMITH
T. L. SMITH CO. MILWAUKEE

Smith Speed Needed Today

Work put off last year must be speeded up today. With the biggest construction program this country has ever known, speed and dependability are vital factors.

Now that money has been released for big projects, "When can it be finished?" is the question put to every construction man.

Since the last century when the late T. L. Smith developed the Smith Tilting Mixer, there has never been a piece of equipment that could compare with it in any respect, because it combines in its patented features all the essentials of simplicity, ruggedness, speed of charging and discharging, thorough mix, and long life.

You can load the Smith Mixer from any level, since Smith Tilting Mixers are equipped with Power Loader and extended track which permits taking the aggregate from a lower level up to the mixer.

When the strenuous job of rushing the construction of the mammoth Muscle Shoals plant was considered, —the biggest concrete mixers had to be used. They were Smith Tilting Mixers of 112 cu. ft. capacity—biggest in the world.

The widespread use of Smiths is not the result of chance, good selling, or advertising,—it is because contractors and engineers know what equipment gives them the best results with lowest maintenance costs.

For any concrete job you have, there is a Smith that will meet your requirements.

Ask for Catalog

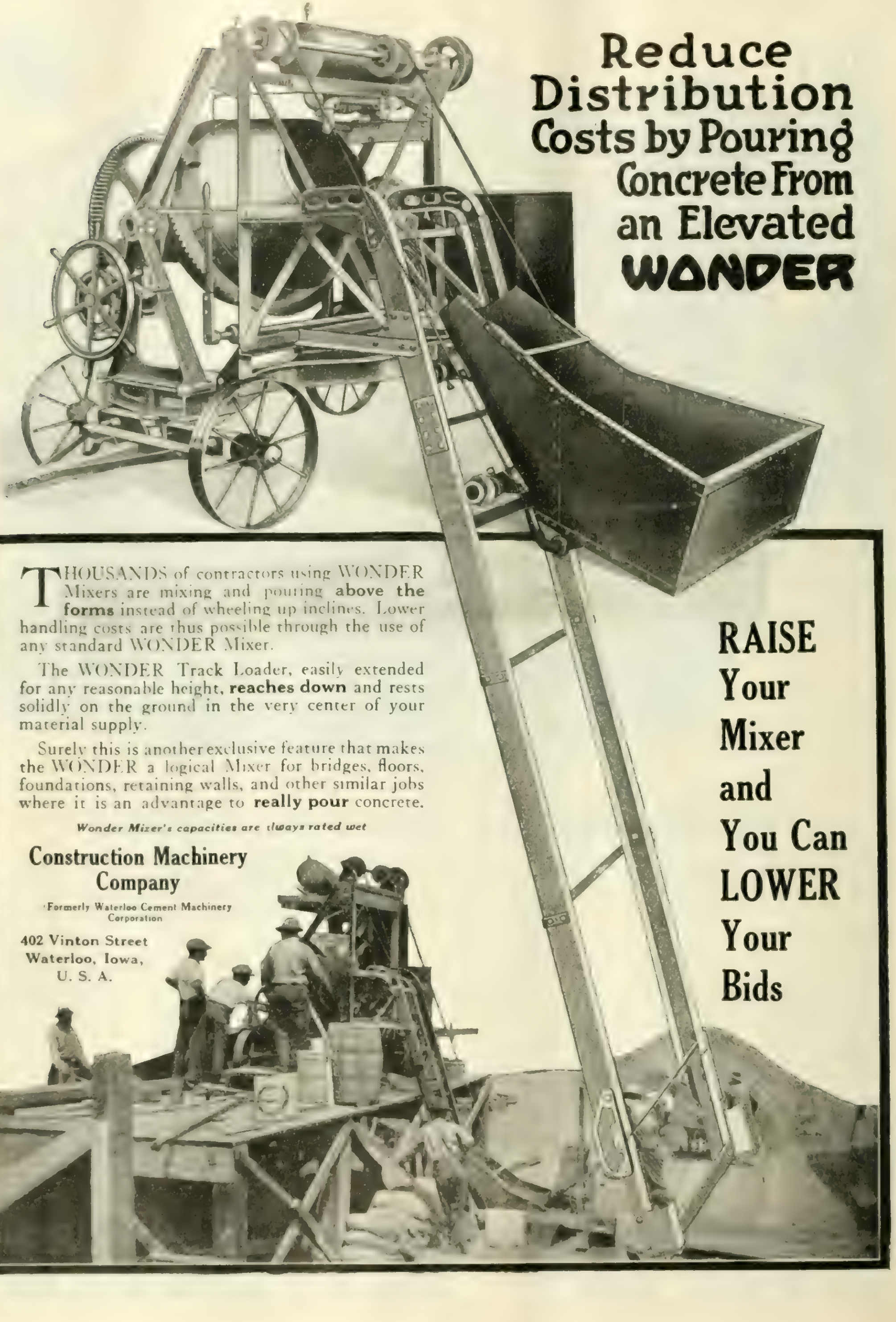
THE T. L. SMITH COMPANY
1164 32nd Street Milwaukee, Wisconsin

New York Office and Warehouse 50 Church Street
Chicago Office Old Colony Bldg. Western Warehouse San Francisco

Agents in Principal Cities

SMITH MIXERS

Reduce Distribution Costs by Pouring Concrete From an Elevated WONDER



THOUSANDS of contractors using WONDER Mixers are mixing and pouring **above the forms** instead of wheeling up inclines. Lower handling costs are thus possible through the use of any standard WONDER Mixer.

The WONDER Track Loader, easily extended for any reasonable height, **reaches down** and rests solidly on the ground in the very center of your material supply.

Surely this is another exclusive feature that makes the WONDER a logical Mixer for bridges, floors, foundations, retaining walls, and other similar jobs where it is an advantage to **really pour** concrete.

Wonder Mixer's capacities are always rated wet

Construction Machinery Company

(Formerly Waterloo Cement Machinery Corporation)

402 Vinton Street
Waterloo, Iowa,
U. S. A.

RAISE Your Mixer and You Can LOWER Your Bids

Government Pier, Charleston, S. C.

No matter what the job, if it involves the unusual in concrete work we are prepared to undertake it. This department of our activities is entirely separate from our placing of standard Raymond Concrete Piles.

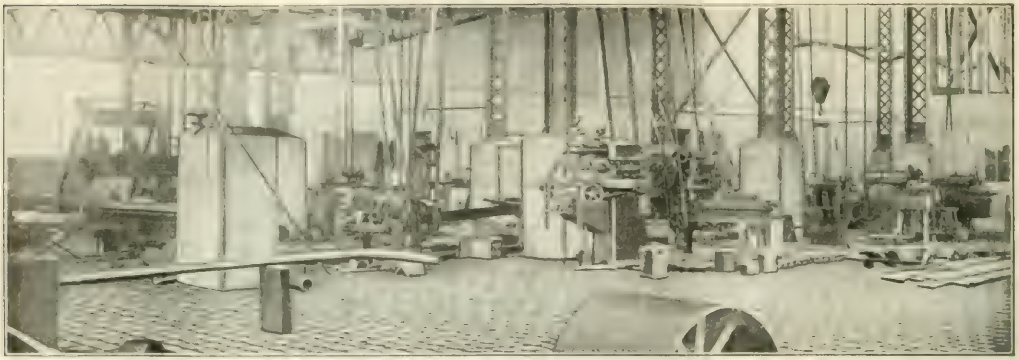
Docks — Piers — Bulkheads — Bridges — Retaining Walls — Etc.

Raymond Concrete Pile Company

New York, 140 Cedar Street
Chicago, 111 W. Monroe Street
Raymond Concrete Pile Co., Ltd., Montreal, Can.

Branch Offices in All Principal Cities

A Form for Every Pile—A Pile for Every Purpose



Rodd Floors of California Redwood Blocks

For Factories of all kinds, Machine Shops, Warehouses and Offices

RODD Floors of untreated Redwood blocks solve the problem of providing floors that combine endurance, comfort and economy.

Hard, rigid floors wear down unevenly and soon become rough and dirty. Rodd floors are resilient and reduce the wear and tear on trucks and injury to materials. They are warm, comfortable and easy to keep clean.

Floors of treated wood blocks were a step in the right direction. But their odor, stickiness, and tendency to swell and buckle under variable conditions, temperature and moisture limited their use.

Redwood Block Floors Stay Flat and Wear Indefinitely

Nature made Redwood a remarkably good floor material. The **natural,** odorless preservative which permeates Redwood during the growth of the tree makes artificial preservative treatment unnecessary. Rodd Floors of California Redwood blocks are odorless and not sticky. Thoroughly seasoned and dried, Redwood neither swells nor shrinks. Floors stay tight and flat.

The ends of the wood fibre iron out into a smooth compact surface that grows stronger under heavy traffic. Rodd floors do not rut, splinter or corrugate. They are resilient, easy on the feet and easy on the trucks and are practically dustless. Under the severe conditions found in iron and steel plants and machine shops Redwood block floors have repeatedly lasted in good condition over a quarter of a century.

Rodd Specification Floors for all types of service

Rodd specifications include floors designed for all load and service conditions and for resurfacing worn out plank or concrete floors.

There are Rodd specifications for floors that don't have to be absolutely smooth and for floors that have to be sanded and finished so that they won't catch lint—foundry, round house, machine shop and platform floors, and smooth, quiet, odorless floors for waiting rooms and offices.

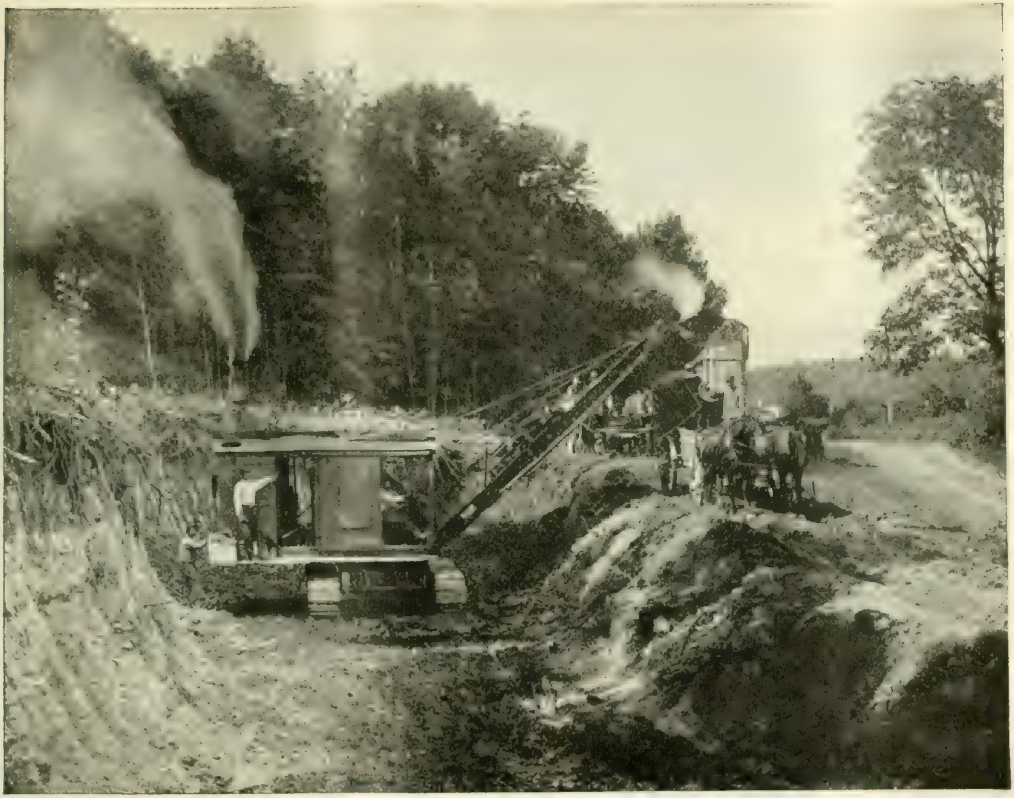
Rodd Floor Engineering Service

After years of experience in installing floors for many of the nation's largest railroad and industrial organizations, The Rodd Company now standardizes on California Redwood for block floors. Exhaustive tests by The Pacific Lumber Company and by our own organization have conclusively proved the superiority of Redwood Block Floors for all purposes.

We undertake the complete installation of floors and will gladly furnish specifications and estimates. Inquiries are invited.

THE RODD COMPANY
[illegible] CENTURY BLDG., PITTSBURGH, PA
EASTERN CONTRACT ENGINEERS FOR REDWOOD BLOCK FLOORS
Manufactured by

T P L Co
The Pacific Lumber Co.
Redwood
The Largest Manufacturers and Distributors of California Redwood



A No. 6-T Austin Steam Shovel side-cutting to a depth of nearly fifteen feet on a cut-off near Rochester, N. Y.

WHAT DOES IT DO?

Many things, *well!* For the Multi-Utility Austin Dragline stands for far more than versatility, valuable as that quality is.

It stands for a careful designing and rugged construction which make the specific adaption of the machine as effective as if it were built from the ground up for one purpose only.

Grading on a road contract, the Austin Dragline with Shovel attachment is none the less a Shovel because it can be converted into a Clamshell, if your next contract requires one.

Its very versatility necessitates a power equal to the maximum requirement. This means a reserve strength and power as applied to the average task—a surplus which spells satisfaction and a worth-while profit.

The 5 in 1—Dragline, Crane, Skimmer, Clamshell and Shovel.

CUBE MIXERS
CUBE-HEX PAVERS
CONCRETE TAMPERS
GASOLINE LOCOMOTIVES
INDUSTRIAL CARS
BATCH BOXES
WAGON LOADERS
SUBGRADERS
TRUCK TURNTABLES
TRENCH MACHINES
WHEEL EXCAVATORS
BACKFILLERS
DRAGLINES
CLAMSHELLS
CRANES
SHOVELS
SKIMMERS

The largest manufacturers of the most comprehensive line of earth-moving and concrete mixing machinery in the world.

Our new Dragline catalog, DL-9, sent promptly on request

Austin Machinery Corporation
Railway Exchange Bldg.
Chicago, U. S. A.

BIRMINGHAM
DAVENPORT
DETROIT
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WOODSTOCK, ONT

AUSTIN
MACHINERY
"MOVES THE EARTH—
MIXES THE CONCRETE"
TRADE MARK

BOGALUSA'S HISTORY-MAKING REFORESTATION OPERATIONS ASSURE A PERPETUAL SUPPLY TO OUR TRADE.

"'BOGALUSA' STENCILED ON YOUR SOUTHERN PINE IS LIKE A CERTIFICATION ON A CHECK."

"IN THE DAY'S WORK."

20 pieces, 13¾ x 14¼—59 feet, square-edged and sound, from

BOGALUSA

Trade-Mark Reg. U. S. Pat. Office

"where the finest SOUTHERN PINE in the World's Markets comes from."

Our facilities enable every "Bogalusa" dealer to fill any order of *ANY SIZE ANY TIME* promptly and with exactness.

Big Timbers for Railroad or Marine demands—or humble everyday crating, or box lumber (as well as a Complete Line of the usual yard and shed stock.) 25 YEARS of CAPACITY PRODUCTION ahead of us in *our own unequaled stands* of THE FINEST VIRGIN TIMBER EXTANT, plus the knowledge of "BOGALUSA" products assured to you IN PERPETUITY by our far-reaching *reforestation* operations. You are thus protected, in the most practical way, in the complete satisfaction of your Southern Pine requirements during the life of your business.

Superior standards of manufacturing technique, with strict grading per Factory Muuals, American Society for Testing Materials and American Railway Engineering Association are among the other factors that have made the name "BOGALUSA" indeed

"A WORD TO RELY ON."

Write us for full particulars as to detailed special service on special items. Our response will be personal, candid and prompt.

SALES SERVICE DEPARTMENT

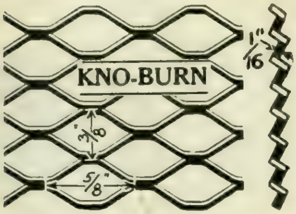
GREAT SOUTHERN LUMBER COMPANY: 1624 4th Avenue, BOGALUSA, LA.

"FROM A LATH TO BRIDGE TIMBERS, SPECIFY BOGALUSA *TRADE-MARKED PINE AND REST EASY."*

Nemco EXPANDED METAL Products

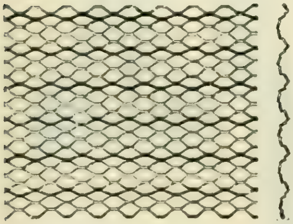
For Every Building Requirement

KNO-BURN



AN economical flat, small diamond meshed lath for interior plastering stucco, ratproofing and fire stopping. Requires a minimum amount of plaster, very rigid, yet easily cut, shaped and plastered, 24, 25, 26, 27 gauges—Sheets 24 x 96 in. Furnished painted, cut from Galv. Sheet, Pure Iron and Copper Bearing.

CORRUGATED



SELF-FURRING. Especially recommended for stucco. Furnished in either the KNO-BURN or EUREKA types of mesh and in the same weights, gauges and finishes.

FREE SAMPLES
CATALOGS
SPECIFICATIONS

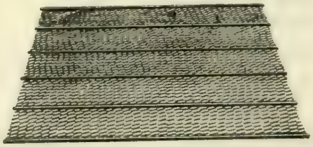
Dealers Everywhere
Prompt Deliveries

ECONO
Expanded Metal

ECONO STEEL
TRADE MARK
REINFORCING

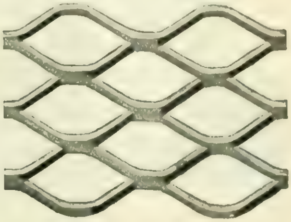
A MESHED reinforcing for all types of concrete work. Saves time and labor of tying and placing bars. Large flat sheets in various gauges and sizes of mesh, ranging from ½ in. x 1½ in. to 5¼ in. x 12 in. (small meshes mostly used for machine guards, open partitions, etc.)

LONGSPAN



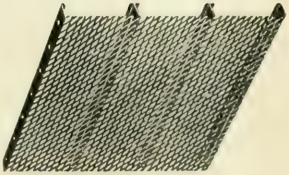
SELF-FURRING lath for partition work, ceilings, etc. U-ribs ⅜ in. high are easily spliced. Rigid, ships well. Sheets 2 ft. x 8 ft. 24, 26, 28 gauges.

EUREKA



FLAT lath. Especially indicated for 2 in. Solid Partitions, Ornamental Plastering and wherever as small a meshed lath as KNO-BURN is not required. 24 and 26 ga. Sheets (respectively) 22 in. and 21 in. x 96 in. Painted, Cut from Galv. Sheet, Pure Iron and Copper Bearing.

T-RIB CHANELATH

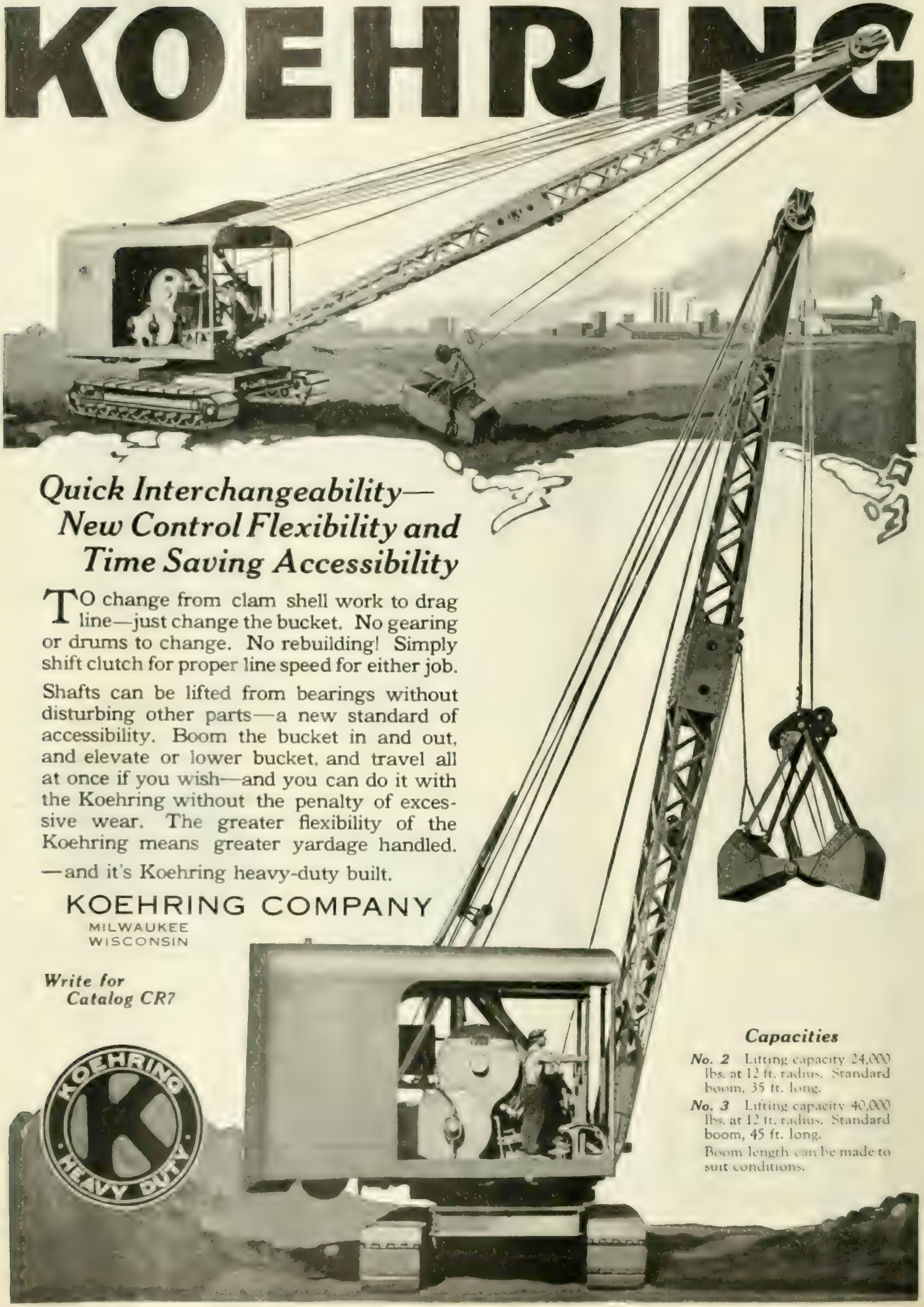


USED with equal satisfaction either as a self-furring plastering lath or as a combined form and reinforcing for concrete. Especially indicated for roofs, partitions, T-ribs ⅞ in. high. 24, 26, 28 gauges. Sheets 4 in. to 48 in. wide. Lengths 3 to 12 ft.

NORTHWESTERN EXPANDED METAL CO.

1201 Old Colony Building, Chicago, Ill.

KOEHRING



Quick Interchangeability— New Control Flexibility and Time Saving Accessibility

TO change from clam shell work to drag line—just change the bucket. No gearing or drums to change. No rebuilding! Simply shift clutch for proper line speed for either job.

Shafts can be lifted from bearings without disturbing other parts—a new standard of accessibility. Boom the bucket in and out, and elevate or lower bucket, and travel all at once if you wish—and you can do it with the Koehring without the penalty of excessive wear. The greater flexibility of the Koehring means greater yardage handled.

—and it's Koehring heavy-duty built.

KOEHRING COMPANY
MILWAUKEE
WISCONSIN

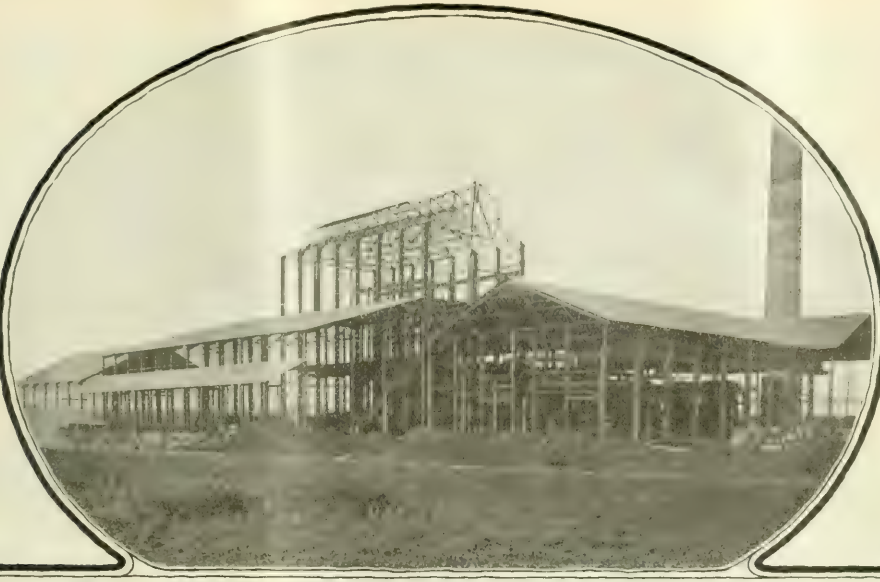
Write for Catalog CR7

Capacities

No. 2 Lifting capacity 24,000 lbs. at 12 ft. radius. Standard boom, 35 ft. long.

No. 3 Lifting capacity 40,000 lbs. at 12 ft. radius. Standard boom, 45 ft. long.

Boom length can be made to suit conditions.



BLAW-KNOX

STRUCTURAL STEEL

BLAW-KNOX PRODUCTS

- Road Building Equipment
- Clamshell Buckets
- Prudential Sectional Steel Buildings
- Steel Forms for Concrete Construction
- Fabricated Steel Specialties
- Pressed, Riveted and Welded Plate Work
- Forge and Hammer Welding
- Water Cooled Appliances for High Temperature Furnaces
- Steel Transmission Towers and Poles
- Gas Producers—Dolomite Gun

Knowledge of structural steel, excellent shop and shipping facilities and trained engineers specializing in design and construction — a reputation for living strictly up to contracts has established Blaw-Knox Company among the foremost fabricators in the country.

Mill buildings, manufacturing plants, bridges, steel poles, transmission towers, radio towers, trusses, crane runways and miscellaneous construction of every description have been Blaw-Knox Specialties for years.

Illustrated above is a complete sugar refinery designed, fabricated and erected for the Caribean Sugar Company, Cuba—your structural and plate requirements can be served equally as well.

BLAW KNOX COMPANY

PITTSBURGH, PA.
603 Farmers Bank Bldg.

New York-Chicago-Detroit-Baltimore
Birmingham-San Francisco-London, Eng.

Full Protection to all kinds of Concrete Work

Elastic used in this riprap work by Miami Conservancy district near Dayton, Ohio.

ANY 100 yard stretch of concrete work will expand or contract approximately 2½ inches when the temperature changes 100 degrees.

This expansion or contraction is unavoidable and unfailing whether the change in temperature takes place in a few hours or a year's time.

Taking a factor of safety of four (4) enough expansion joints should be used to provide for expansion of 4 x 2½ inches or 10 inches, hence, there should be 20 half-inch expansion joints in every hundred yards.

Carey Elastite used on this basis has been employed in bridges, viaducts, dams, reservoirs, grand stands, and in every instance is successfully protecting the work against buckling and cracking.

It costs little to provide absolute safety from stresses due to inevitable changes in temperature.

Write for sample and full particulars to

The Philip Carey Company

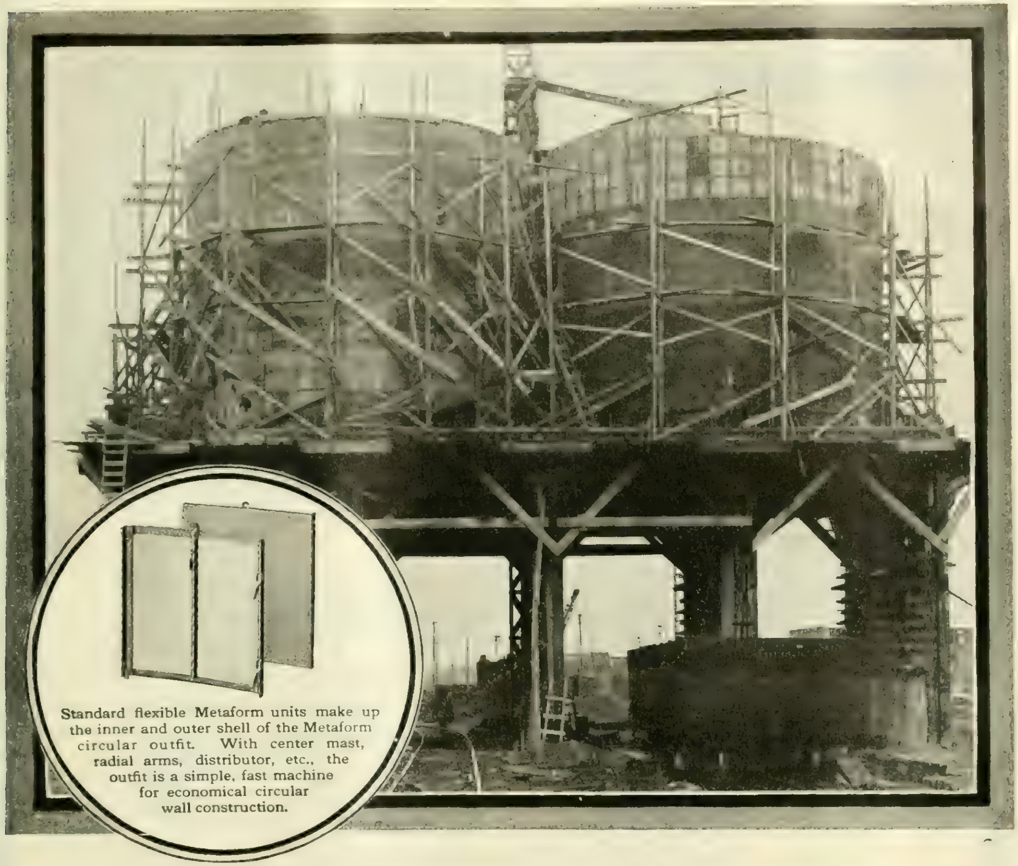
7 Wayne Avenue, Lockland, Cincinnati, Ohio

Carey Elastite

NAME REG. U.S. Patent Office

EXPANSION JOINT

5-21



Standard flexible Metaform units make up the inner and outer shell of the Metaform circular outfit. With center mast, radial arms, distributor, etc., the outfit is a simple, fast machine for economical circular wall construction.

—Total, 14½ Days—with a Metaform Outfit

TWO huge coal pockets—each 33 feet in diameter and 30 feet high, with floor slabs 30 feet from the ground—built in 14½ ten-hour working days! Such was the record set with a Metaform circular outfit at the New York Central's new engine terminal, Solvay, New York.

Metaform standardized circular outfits offer the cheapest, fastest, best method of building every type of circular monolithic concrete structure. With them, hundreds of contractors are making bigger profits out of silos, grain elevators, coal pockets, water tanks, smoke stacks, etc. Full information on request.

Fill in the coupon or attach to your letterhead. The Metaform books will be sent to you free.

METAL FORMS CORPORATION
MILWAUKEE WISCONSIN

Metaform

Metal Forms Corporation
1436 Booth Street, Milwaukee
Gentlemen: Kindly send me the two books on Metaform Equipment.
Name
Address

What Is Cement?

What is this finer-than-flour building material called cement, that you can mix with water, sand, and stone or pebbles, and cast into all sorts of shapes that become as hard and enduring as solid rock?

* * *

Portland cement consists principally of silica, lime, and alumina. In cement manufacture these are obtained from (1) Cement rock and limestone; (2) Limestone or marl and shale or clay; (3) Blast-furnace slag and limestone.

First the rock is quarried and transported to the mill. Then it is ground to a powder, analyzed, and the several ingredients mixed in accurate proportions.

Next it is subjected to long and gradually increasing heat until, at about 3000 degrees Fahrenheit, the mixed materials decompose and fuse into hard balls, known as clinker.

Then this hard clinker is cooled, mixed with a definite proportion of gypsum. and again ground to a powder so fine that at least 78 per cent of it will pass through a sieve having 40,000 holes to the square inch.

Finally this finished product must be analyzed to determine that it conforms to the exacting specification requirements of cement manufacture, packed in bags and placed in cars for shipment.

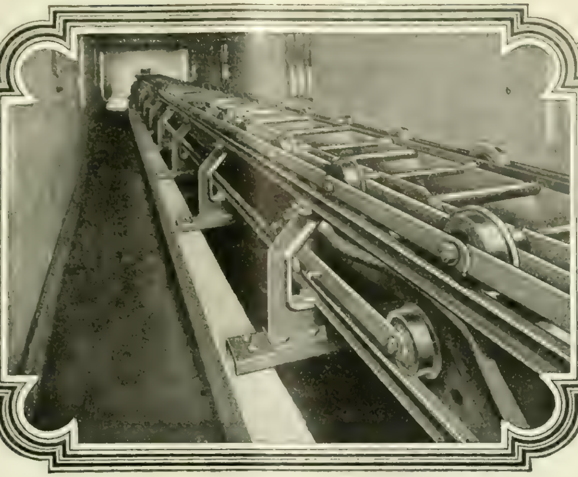
* * *

The manufacture of cement is a complex process involving great care, skill and expense, and requiring an enormous capital investment.

This Is the Age of Cement

PORTLAND CEMENT ASSOCIATION
111 West Washington Street
CHICAGO

TO FURTHER THE BEST INTERESTS OF CEMENT USERS



ONE of the biggest factors entering into the cost of power plant operation is the handling of coal and ashes. More money—dividends—is wasted in this department of the power plant than in any other.

THE PERKINS PIVOTED BUCKET CARRIER will cut this expense to a minimum and effect a more efficient, cleaner and safer power plant. Its economy of operation, simplicity of construction, and reliability of performance, makes it the ideal machine for this service. It requires a minimum amount of attention and will stand abuse of hard, continuous usage.

Numerous installations, many in some of the largest power plants in the country, give proof of its unquestioned superiority for handling coal and ashes, as well as stone, coke, cement, clinker, etc.

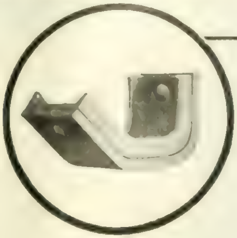
Webster Engineers are specialists in the art of material handling and stand ready to assist you in the proper selection of machinery for your particular requirements. Consult them.

THE WEBSTER MFG. COMPANY

4500-4560 CORTLAND ST., CHICAGO

Factories-Tiffin, O. *and* **Chicago - Sales Offices** *in* **Principal Cities**

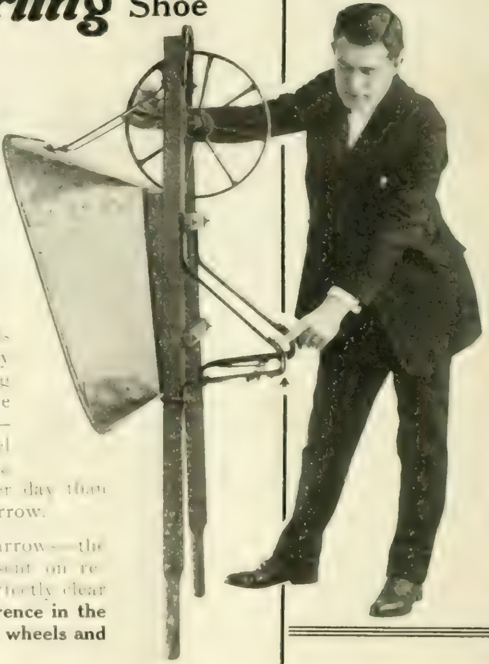
Wear the Shoe Instead of the Leg



Doubly Reinforced

From the ground up every detail of the Sterling Wheelbarrow is built for lasting service.

The Sterling Shoe



By **riveting** a broad flat shoe on our heavy steel channel legs we have eliminated one of the faults most prevalent in all wheelbarrow foot and leg troubles.

The Sterling shoe is only one of the many reasons why Sterling Wheelbarrows have greater stability—last longer—wheel easier and handle a greater tonnage per day than any other wheelbarrow.

If you use wheelbarrows—the Sterling catalog (sent on request) makes it perfectly clear that **there's a difference in the way that a Sterling wheels and wears.**

Ten Other Sterling Features

10 Spoke Wheels
Malleable Wheel Guard
Self Lubricating Wheels
Cold Rolled Steel Shafts
Patented Handle Clamps
Malleable Wheel Supports
Tested Clear Maple Handles
Riveted Leg Braces
Balanced Load
All Parts Interchangeable

Sterling Wheelbarrow Company

NEW YORK
BOSTON
CLEVELAND

MILWAUKEE, WIS.

CANADIAN AGENTS-MUSSENS LIMITED, MONTREAL, TORONTO, WINNIPEG, VANCOUVER

DETROIT
CHICAGO
ST. LOUIS

[illegible]

The Severest Test of Wire Rope Is Found In Logging Operations

The Clyde Iron Works Recommend and Equip Their CLYDE SKIDDERS with

WILLIAMSPORT PURPLE STRAND

The Toughest Wire Rope Made

Clyde Iron Works adopted Williamsport Wire Rope only after the severest and most exhaustive tests of the various standard, wire ropes.

And too, it was not "special" wire ropes built for this test but ropes bought in the open market without our knowledge.

For a great many years Williamsport has specialized on high quality ropes and an inspection of our plant and methods—to which wire rope users are invited—will convince anyone absolutely that here is the wire rope you can trust.

The Williamsport patented Telfax Tape Marker presents positive definite, indestructible evidence of each grade and eliminates the possibility of substituting a different grade from what you buy.

The test of service will convince you of the amazing efficiency of Williamsport Wire Rope—and regardless of the rope you are now using, you owe yourself this test.

Write for Our Factory Prices

WILLIAMSPORT WIRE ROPE COMPANY

Main Office and Works
Williamsport, Penna.

"accepted as the best"

Gen'l Sales Office: Peoples Gas Bldg.
Chicago, Illinois

Insley Concrete Placing Equipment

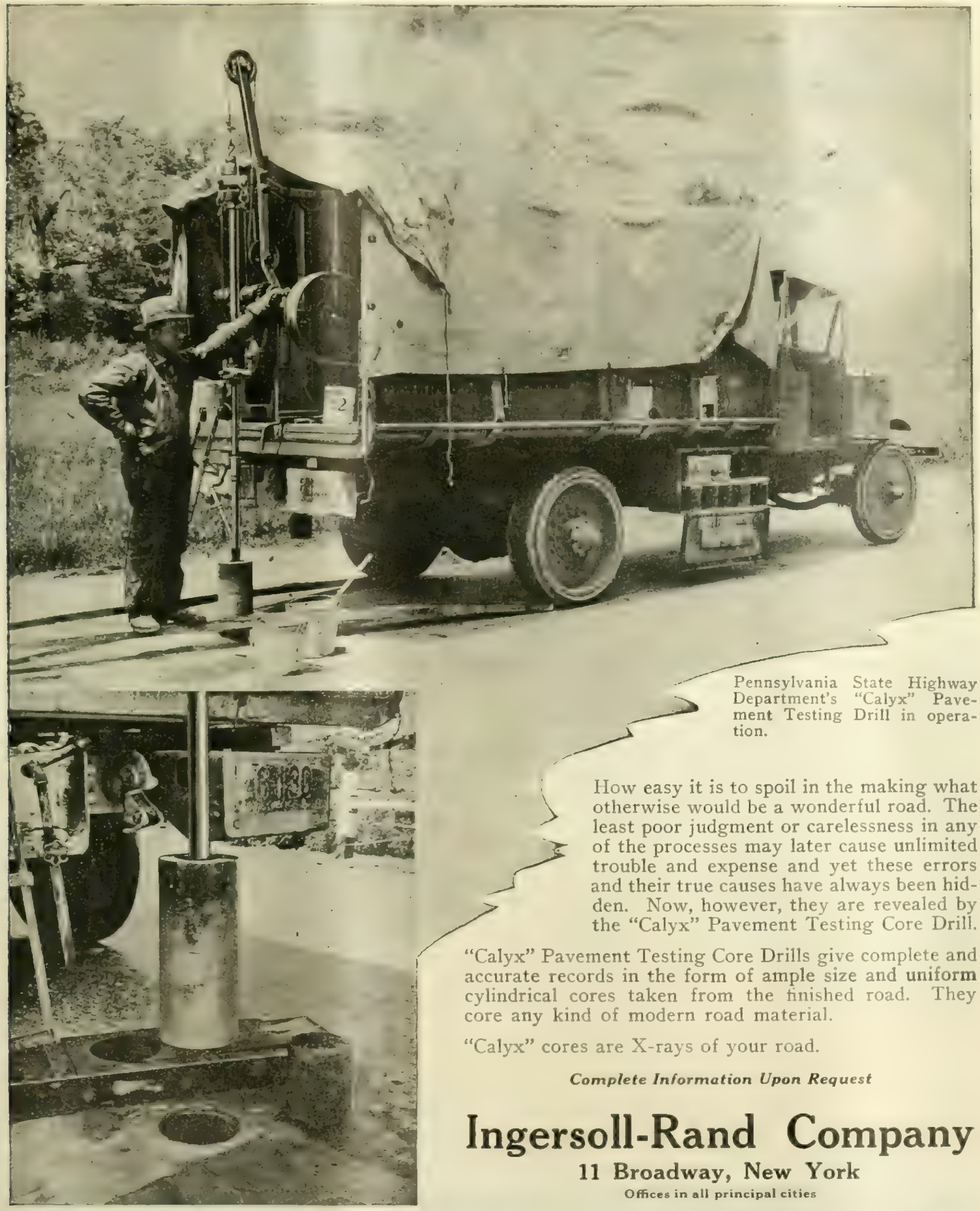
PIONEERS in the field, Insley engineers have constantly improved their equipment so that the INSLEY STEEL TOWER, QUICK SHIFT, COUNTERWEIGHT CHUTE plant represents the utmost obtainable in the way of labor and time saving plant for use in connection with the larger type of concrete construction.

This equipment has been standardized upon by a large number of firms engaged in concrete construction. We would welcome an opportunity to explain just how it will save money for you.

The illustration below shows Insley Steel Tower, Quick Shift, Counterweight Chute equipment as used by McCormack-Combs Construction Company on their Missouri Pacific Hospital work at St. Louis. James Stewart & Company, General Contractors.

INSLEY MANUFACTURING CO.
Engineers and Manufacturers
INDIANAPOLIS

INSLEY
CONCRETE PLACING EQUIPMENT
INDUSTRIAL CARS — DUMP BUCKETS
STEEL DERRICKS



Pennsylvania State Highway Department's "Calyx" Pavement Testing Drill in operation.

How easy it is to spoil in the making what otherwise would be a wonderful road. The least poor judgment or carelessness in any of the processes may later cause unlimited trouble and expense and yet these errors and their true causes have always been hidden. Now, however, they are revealed by the "Calyx" Pavement Testing Core Drill.

"Calyx" Pavement Testing Core Drills give complete and accurate records in the form of ample size and uniform cylindrical cores taken from the finished road. They core any kind of modern road material.

"Calyx" cores are X-rays of your road.

Complete Information Upon Request

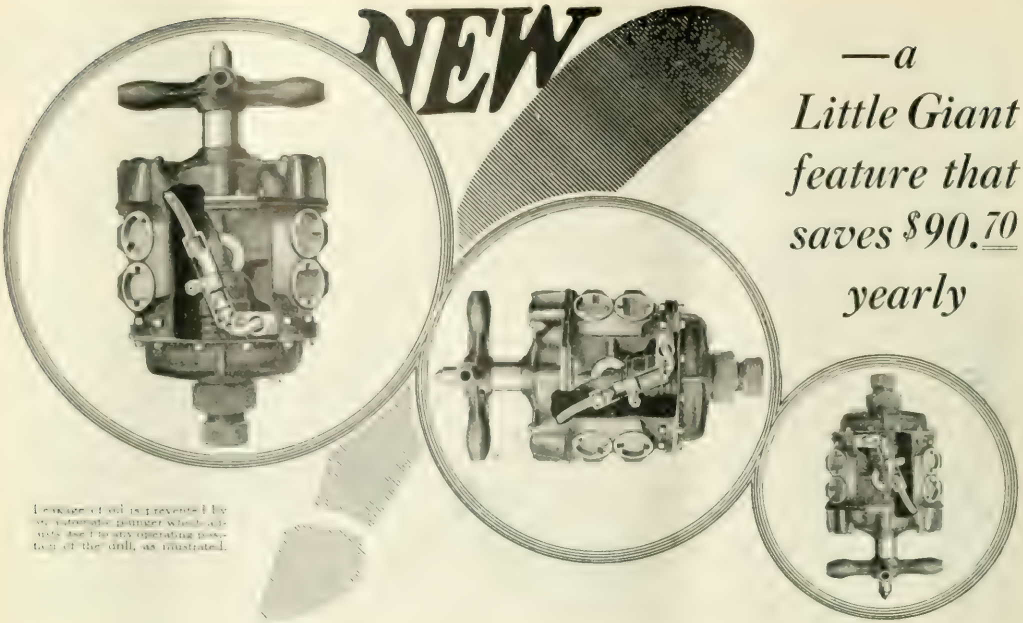
Ingersoll-Rand Company

11 Broadway, New York

Offices in all principal cities

14 CD

Ingersoll-Rand



—*a Little Giant feature that saves $90.70 yearly*

Leakage of oil is prevented by an automatic plunger which adjusts itself to any operating position of the drill, as illustrated.

EFFICIENT lubrication — an air drill's best friend — was problematical and expensive when air drills required semi-daily lubrication due to oil escaping with air passing the pistons.

Not so with Little Giant Air Drills equipped with the new patented *Vent Tube* which makes lubrication necessary only *once weekly* when Airoilene Grease, a semi-fluid oil, is used.

The Vent Tube saves $90.70 annually as shown by these figures:

Lubrication before drill leaves tool room, grease		$0.05
Returning drill to tool room for midday lubrication, 30 minutes @ $0.40 per hour	$0.20	
Grease .	0.05	0.25
Daily Cost		$0.30
311 days @ $0.30 . . .		$93.30
Lubricating Little Giant Air Drills once weekly for 52 weeks @ $0.05 .		$2.60
Annual Saving		$90.70

Regardless of the operating position of the drill, oil leakage is made impossible by the plunger in the Vent Tube. Incidentally, this feature reduces repair costs 75%. Add this to the above saving.

The Vent Tube is applicable to most sizes of Little Giants. For a small sum it can be applied to most Little Giants now in service. It costs nothing extra when supplied with new drills.

Address the nearest Branch for complete details.

Chicago Pneumatic Tool Company

Chicago Pneumatic Building • 6 East 44th Street • New York

*Sales and *Service Branches all over the World*

*Birmingham *Boston *Buffalo *Chicago *Cincinnati *Cleveland *Detroit El Paso Erie Duluth Houston Joplin *Los Angeles *Milwaukee *New Orleans *New York *Philadelphia *Pittsburgh Richmond Salt Lake City *San Francisco *Seattle *St Louis Basle *Berlin Bombay Brussels Buenos Aires Christiania Copenhagen *Fraserburgh Havana Helsingfors Honolulu Johannesburg *London Manila Milan Montevideo *Montreal Osaka Paris Rio de Janeiro *Rotterdam Santiago Sao Paulo Seoul Shanghai Tientsin Tokyo Toronto Vancouver Winnipeg

P 190

BOYER PNEUMATIC HAMMERS · · LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS · · VACUUM PUMPS · · PNEUMATIC HOISTS,
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LITTLE GIANT

The World's Standard Air Drill

Building and Structural Monthly Issue

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Roads and Streets—1st Wednesday
(a) Roads
(b) Quarries and Pits
(c) Streets
(d) Street Cleaning

Waterworks and Hydraulics—2nd Wednesday
(a) Water Works
(b) Irrigation and Drainage
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Railways—3rd Wednesday
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(c) Quarries and Pits for Ballast and Concrete

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures

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"Quantitative Economics," A Redundant Term

Political economists are at last beginning to realize that, at least in part, economics is a quantitative science; so one of them has coined the term "quantitative economics." A few engineers have been contending for years that economics is essentially a quantitative science. If this is true, redundancy occurs when the adjective quantitative is applied to economics. No engineer would think of speaking of surveying as quantitative, for it is self-evident that surveying is an application of mathematics and is therefore quantitative.

The time will come when even that branch of economics called "political" will be universally regarded as being quantitative in its nature, but at present even teachers of political economics so seldom regard their specialty as being quantitative that when one of them coins the term "quantitative economics" most of them will think that he is speaking of a new, special branch of economics!

The average daily paper editor seldom regards economic problems as being quantitative, for, if he did, he would not throw into the waste paper basket most of the economic discussions that contain quantitative data. An experienced writer recently said: "If any article contains many statistics it is almost certain to hit the floor of the editorial office to which it has been sent within five seconds after the editor has scanned it."

Josh Billings' old apothegm, "Figgers don't lie but liars will figger," seems to be a favorite with editors. They have evidently resolved to take no chances with "figgers" regardless of the source or the suggested applicability. If a well known speaker asserts that high freight rates have been the main cause of industrial depression, many an editor will quote the statement. But if a railway president replies by pointing out that the total annual freight charges are only 10 per cent of the total retail price of all commodities sold annually, even so slight an appeal to "figgers" stands slight chance of being quoted editorially. When the Interstate Commerce Commission ordered a 10 per cent reduction in freight rates, to take effect July 1, many an editorial writer rejoiced in type at the boon to industry through lower prices that would follow such a slash in freight rates. Boon indeed! Ten per cent of 10 per cent is 1 per cent. Hence the effect of the freight reduction on the average retail price level can not exceed 1 per cent, and of course will not equal that infinitesimal, because it will be mostly absorbed by the retailer.

But even such simple quantitative analysis is beyond the average editor. Talk to him in percentages and his mind wanders, wanders as it did 10, 20, 30 or 40 years ago in the schoolroom when percentage and the "rule of three" were his greatest soporifics.

Under such conditions it seems almost hopeless to try to introduce engineering methods of quantitative analysis into the field of political economics; but unless success ultimately follows the attempt, there never will be truly economic government in the world.

Let Estimators Beware of Rising Prices

For four months the wholesale commodity price index has been rising. This not only registers the upward turn of general prosperity but should act as a warning to contractors and others who have been anticipating a decline to the prewar level of prices and wages.

Retail prices, the cost of living, wages and freight rates are all about 60 per cent above the level of the year 1913. Wholesale commodity prices average about 50 per cent above the 1913 level, but in May they rose 3.5 per cent above the April level, at which rate they, too, will be 60 per cent above 1913 by the end of July.

Labor unions have vigorously resisted attempts to put their wages in line with the cost of living, but they are slowly being forced to accept a decrease in wages comparable with that of farmers and other non-unionized workers.

Common labor begins to show evidence of scarcity at prevailing wages in many places. It is probable, therefore, that common labor wages will rise in many parts of the country before the year is over.

With a rising tide of prosperity average wages and prices are apt to increase 10 to 20 per cent within a year. Let no contractor or engineer make the mistake of not allowing for such a contingency in estimating the cost of work to be done a few months hence.

Exemplifying the rapidity with which the price of structural materials may rise we may cite steel. The Iron Trade Review index of steel prices stood at 125 for April, and is now 141, an increase of 14 per cent in two months. Steel is still only 41 per cent above the average price for the year 1913 and may rise another 14 per cent in the next two months.

In April the average price of common red brick in New York was $16.75; in May it was $19.81, an increase of 18 per cent in a single month.

Let the estimator beware.

Trial of Eastern Cement Manufacturers Ends in Jury Disagreement

After a trial that lasted two months, the jury failed to agree on a decision relative to the alleged conspiracy of the eastern cement manufacturers to restrain interstate commerce. It is stated that seven jurors voted for acquittal and five for conviction. If so, this may be regarded as a victory for the cement manufacturers, because the average jury would probably be prejudiced in advance against any group of manufacturers charged with combining to raise prices. Newspapers, during the past five years, have harped editorially to the tune of "profiteering" until most daily paper readers are prepared to condemn almost any manufacturer or merchant regardless of evidence.

The Government's case was based almost entirely on circumstantial evidence, the strength of which lay mainly in the inferences drawn from statistics. The defense proved definitely that many of these inferences were wrong, and evidently shook the faith of the majority of the jurors in the remaining inferences.

Four very well known men testified for the defense, Gen. George Goethals, Edward N. Hurley, Prof. Thomas Adams of Yale and Richard K. Meade.

Gen. Goethals testified that in purchasing some 8,000,000 barrels of cement for the Panama Canal, competition among the cement companies was active, ten or more bids being frequently received at prices that differed as much as 20 cts. per bbl.

Mr. Hurley, former chairman of the Federal Trade Commission, testified that the Government had encouraged the formation of such organizations as the cement manufacturers' association, and that he had personally advised this association to adopt uniform cost accounting and other practices that had subsequently been cited as evidence of restraint of trade. He stated that 15 per cent profit was needed in normal times to provide a surplus for subnormal times.

Prof. Adams testified that in any industry whose product is standardized (as is the case with cement) competition tends to effect a substantial equality in market prices at a given time and place. He quoted many economists to this effect. Speaking of profits, he testified that the national banks of America had averaged 8.6 per cent annual net earnings on their capital and surplus during the past 45 years; and that an industrial company should average 12 per cent, because of the greater risks and wider fluctuations in its business.

Richard K. Meade testified that the average cost of building and equipping a cement plant in 1919 was $3.79 per bbl. of annual capacity, and the average plant had depreciated about 25 per cent below this value; that the rock deposits owned by the companies were worth about 0.75 ct. per bbl. producible. Based on these data, he estimated the depreciated value of the defendant companies' properties to be as follows in 1919:

Plant	[illegible]
Rock deposits	[illegible]
Working capital	[illegible]
Total	[illegible]

The net earnings of these companies during 1919 and 1920 were, respectively, 3.3 and 2.0 per cent. The companies' income tax statements as to invested capital showed an investment about half the $151,000,000 appraised value. On the invested capital their combined net earnings had ranged from a maximum of 6.7 per cent in 1919, to as low as 1 per cent in 1915, the average for the past 9 years being 4.2 per cent.

The Government attorney, not satisfied with a partial defeat, will probably ask for a new trial.

Business of Second Half Year Equal to That of First Half

The following weekly summary was written by the editor of Engineering and Contracting for the Chicago Journal of Commerce:

Although no economic problem can be solved without quantitative or statistical data, still too many business men base important decisions on "hunches," instead of on "figures." Thus it is customary with a large fraction of advertisers of construction materials and machines to curtail their advertising during the last half of the year, because they are ignorant of the fact that the volume of contracts awarded during the last half of the year usually almost equals that of the first half.

During the year 1921 American public works contracts (other than buildings) were as follows:

First 6 months	$364,051,000
Last 6 months	324,228,000
Total for 1921	$688,279,000

Contracts awarded for buildings during the last half of 1921 exceeded by one-third the building contracts awarded during the first half, as shown by the following totals:

First 6 months	$1,236,552,000
Last 6 months	1,614,835,000
Total for 1921	$2,851,387,000

It is true that 1921 was somewhat exceptional in that a special "drive" was made to relieve unemployment by speeding up construction work. But while this had some effect on public works contracts, its effect was inappreciable on private contracts. Since nearly all buildings as "private," it follows that the excess of building contract awards during the last half of 1921 is attributable to other causes than propaganda to relieve unemployment. Chief among these causes were two: First, the substantial drop in building material prices and labor; second, the progressive increase in shortage of residential accommodations in most growing cities.

Since there is still a great shortage both in residences and in public works (roads, streets, waterworks, sewers, etc.), it is probable that the last half of 1922 will also exceed the first half in the total volume of public and private construction. As stated last week, construction for the first five months of 1922 was practically double that for the first five months of 1921, measured in units of construction material and days of labor. The data thus far available for June show a continuance of this remarkable construction revival, which forecasts a record breaking year.

May Structural Sales at 82 Per Cent of Fabricating Capacity.—Sales of fabricated structural steel during May amounted to 82 per cent of fabricating capacity, according to reports made to the Department of Commerce by firms comprising 70 per cent of the fabricating capacity of the United States. The May business reported by 82 firms, having a capacity of 130,600 tons, totaled 106,620 tons as against April sales of these same firms amounting to 121,211 tons, or at the rate of 93 per cent of capacity. Total sales throughout the United States, based on the reported percentage and a total capacity of 180,000 tons, amounted to 146,900 tons in May, while revised figures for April give a total of 165,900 tons. The April figures are based on reports from 87 firms, having a total capacity of 132,600 tons, whose sales amounted to 122,198 tons, or at the rate of 92 per cent of capacity.

Portland Cement Output in May.—Statistics prepared under the direction of G. F. Loughlin of the U. S. Geological Survey show that 11,176,000 bbl. of Portland cement were produced in May; that shipments amounted to 12,749,000 bbl., and that 12,897,000 bbl. were in stock at the end of the month.

Book Review

The House-Owner's Book.—By Allen L. Churchill and Leonard Wickenden. 388 pp. Funk & Wagnalls Co. 1922. $2.08 by mail, postpaid.

This is a non-technical book by authors who are themselves not members of any of the building trades or professions, but who have from choice given much attention to homes and home making, and who have endeavored to present in attractive and reliable form a collection of matter useful to the home-owner or the prospective builder or purchaser. While it is, we believe, obvious that no such book can supply a majority of any particular home-owner's needs for knowledge, there is no question but that the present volume should be of very great value to many persons who prefer to give substantial attention to their homes, and to do a practical portion of the ever-increasing repairs and incidental work connected therewith, instead of turning all such matters over to others hired for the purpose. A few of the many subjects discussed in the 15 chapters are as follows: Financing, characteristics of good construction, elements of carpentry, heating and ventilating, plumbing, painting, electric wiring. The illustrations, though not profuse, are very clear, paper and type are excellent, and there is a good index.

Aluminum for Engineering Structures

Several pages of a former issue were devoted to a digest of a very remarkable report by Messrs. Rosenhain, Archbutt and Hanson on aluminum alloys—namely, the eleventh report to the Alloys Research Committee of the British Institution of Mechanical Engineers. In this issue a brief account of the most remarkable "Y" alloy is given.

Such excerpts give but an inkling of the material contained in the original report, which in turn is little more than a sketch of the results of 7 years' work by a staff numbering at times as high as thirty investigators, and commanding the unstinted resources of the British scientific laboratories. Truly, systematic researches into complex alloy systems have become most prodigious undertakings, far beyond the imagination of the sponsors of the program, started over 30 years ago. Yet it is well that the program was started so early. It is impossible to appraise the influence which the successive reports on steels, brasses, bronzes and aluminum alloys have had on modern technology—they are fundamental.

Aluminum alloys of high strength are not entirely new. The Germans have been using certain of them called "duralumin" for dirigibles since before the war. British and American firms have also been manufacturing duralumin for several years; shop practice is fairly well understood and many laboratory studies have been made on the somewhat bizarre occurrences during heat-treatment. Duralumin contains 3.75 per cent copper, 0.5 per cent magnesium, 0.65 per cent manganese. The present report extends our information by recording the development of "A" alloy, containing 3 per cent copper and 20 per cent zinc; "E" alloy, containing 2½ per cent copper, 20 per cent zinc and 0.5 per cent of both magnesium and manganese; and "Y," containing 4 per cent copper, 2 per cent nickel, 1.5 per cent magnesium.

These newer alloys have all been produced in quantity, and the peculiar combination of properties possessed by "Y" alloy should insure its extended use in industry. It is as light as aluminum, yet as strong as soft steel. It corrodes at an extremely low rate. It retains its strength at moderate temperatures, which fact, coupled with its high heat conductivity, should make it very valuable for engine cylinders and pistons. Furthermore, it has a high endurance limit; that is to say, "fatigue failures" after oft-repeated loadings do not occur until the impressed loads are well up toward the yield point. To appraise this particular property it should be remembered that it is more difficult to add 1,000 lb. to the endurance limit of a metal than it is to add 10,000 lb. to its tensile strength.

We need not expect light alloys of high strength to be adopted as quickly as the radio telephone. They are of course indispensable to aircraft, where weight is a very great consideration and dollars can be spent to save a single pound. Engineers and designers are only slowly realizing that weight is an important factor in all moving parts. But when they are able to convince manufacturers and owners that it is well to put more into a light car or engine and save on its subsequent operation, the aluminum alloys will still have to overcome the competition of heat-treated alloy steels, relatively cheap, very strong and reliable.

Although we can say with much assurance that light metals and alloy steels will form the large structures of the future, it would be vain speculation to attempt to define their mutual relation. The best that scientists can do is to show that such things as high-strength alloys exist; metallurgists then discover how to procure the raw materials cheaply (and here much remains to be done for aluminum) and produce the alloys economically and uniformly. Engineers must then show us how to use these new tools of civilization—even to developing an entirely new technique of design.—Editorial in Chemical and Metallurgical Engineering.

Stresses in Skew Arches

Little information concerning the distribution of stresses in skew arches has hitherto been available to the designing engineer. It has consequently been assumed by many that the skew arch may be treated in the same manner as the right arch, assuming the span to be the distance face to face of abutments measured parallel to the center line of the roadway. This is the method outlined by Rankine and many other writers since his time.

Many instances of behavior of skew arches contrary to the assumptions of this theory are now known to the profession. Some 20 years ago a large skew Monier arch collapsed in Australia with loss of life. An investigation conducted by Prof. W. C. Kernot, of the University of Melbourne, established beyond doubt that the commonly accepted method of calculating skew arches was seriously in error. Certain recommendations were made by him for thickening up both the arch ring and the abutment at the obtuse angle of the arch, or what is the same thing, at the acute angle of the abutment. These recommendations were based on the ascertained fact that there was a great concentration of stress along the short diagonal of the horizontal projection of the arch and that the thrust per lineal foot of abutment was much more intense at the acute angle of the abutment than near the obtuse angle.

Recent investigations made by Prof. Clyde T. Morris of the Ohio State University, and described by him in Engineering News-Record substantiate the general conclusions arrived at by Professor Kernot and others. A model skew arch of 4-ft. span and 3-ft. length, skewed at 45 deg. was constructed and tested under various loadings. Both the vertical and horizontal components of the resultant reaction were measured by means of specially devised springs and it was found that these resultant components act very near the obtuse angle of the arch. Indeed, observations showed that there was even indication of a slight uplift at the acute angle.

The investigations of Professor Morris will be welcomed by engineers who have had to design and report upon skew arches with a somewhat unsatisfactory amount of data at their disposal. Appreciation of the actual stresses existing in structures will be greatly facilitated not only by the laboratory experiment mentioned above, but also by the practical observation of stresses in the skew arches of two bridges over the Scioto River in Columbus, O., now being carried out by Professor Morris. While the indication of the tests of models is definite and pronounced, the results of tests on actual structures of full size will carry greater conviction with practicing engineers.—Editorial in The Canadian Engineer.

Slate Producers Organize National Association.—At a meeting of the slate producers of this country at New York City on April 20, a national organization was established for the purpose of extending and promoting the use of slate products. The executive committee which will formulate all details of the organization consists of Wm. H. Keenan, Bangor, Pa., chairman; G. H. Shinville, Fairhaven, Vt.; N. M. Male, Pen Argyl, Pa.; Roscoe C. Berlin, Slatington, Pa.; F. C. Sheldon, Granville, N. Y.; E. R. Norton, Granville, N. Y.; G. F. Barnard, Boston, Mass.; A. H. Morrow, Treasurer, Pawlet, Vt.; W. S. Hays, Secretary, Philadelphia, Pa.

Quantity Survey Office Established at Milwaukee.—The Associated Engineers, Incorporated, is the name on an organization headed by F. W. Ullins, Jr., Wm. E. Skinner and R. M. Kibbe, established this month in Milwaukee, Wis., for the purpose of conducting quantity surveys and correlated work.

Revision of the U. S. Department of Labor Index Prices

As was noted in these columns last month, important changes have been made in the Bureau of Labor Statistics' index of building material prices which changes have also had a noticeable effect on the average index of all commodities. We give herewith an explanation of the general character of these changes and the reasons therefor taken from the May issue of the Monthly Labor Review. Students of price indices will want perhaps more detailed explanations of the changes made and these we hope to be able to furnish at an early date. We quote the statement in the Monthly Labor Review as follows:

The United States Department of Labor, through the Bureau of Labor Statistics, announces that a revision has been made of its series of index numbers showing changes in the general level of wholesale prices of building materials. The index numbers hitherto computed by the bureau have been influenced to a large extent by lumber prices in the New York market. These were practically the only prices available to the bureau at the inception of its series of weighted index numbers in 1914. It has recently become possible, however, to substitute lumber prices in other and more representative localities for those previously obtained in the New York market. In all such cases the new prices have been carried back to 1913.

In addition to the changes with respect to lumber, structural steel, and a number of other important building materials not previously included in the index have been introduced into the revised index number and carried back to 1913. A comparison of the articles in the old and new index numbers is as follows:

Old Series.—Brick, Chicago; brick, Cincinnati; brick, New York; Portland cement, mill; plate glass (2 series), New York; window glass (2 series), works; spruce lath, New York; lime, plant; Douglas fir (2 series), mills; hemlock, New York; maple, New York; plain white oak, New York; quartered oak, New York; white pine, New York; yellow pine flooring, New York; North Carolina pine, Norfolk; poplar, New York; spruce, New York; white lead, New York; linseed oil, New York; turpentine, New York; zinc oxide, New York; putty, New York; rosin, New York; cypress shingles, mills; and red cedar shingles, mills—total, 29 price series.

New Series.—(a) Lumber: Douglas fir (2 series), mills; gum, St. Louis; hemlock, Chicago; maple, Chicago; plain white oak, Cincinnati; white pine, Buffalo; southern yellow pine flooring, mills; southern yellow pine timbers, mills; poplar, Cincinnati; spruce, Boston; yellow pine lath, mills; cypress shingles, mills; red cedar shingles, mills; (b) brick, average of 82-yd. prices; (c) structural steel, Pittsburgh; (d) Portland cement, average of 6 plant prices; crushed stone, New York; gravel, average of 22 plant prices; hollow tile, Chicago; lime, average of [illegible] plant prices; sand, average of 26 plant prices; slate, quarry; plate glass (2 series), New York; window glass (2 series), works; linseed oil, New York; putty, New York; rosin, New York; turpentine, New York; white lead, New York; zinc oxide, New York; cast-iron pipe, New York; sheet copper, New York; copper wire, mill; lead pipe, New York; wire nails, Pittsburgh; reinforcing bars, Pittsburgh; roofing tin, Pittsburgh; and sheet zinc, mill—total, 41 price series.

Besides the substitution of lumber prices in other localities in place of the New York City prices and the inclusion of a number of new articles in the revised index, the figures have been further revised by the use of the more recent 1919 census data for weighting purposes instead of the 1909 data formerly employed. In the case of lumber, particularly, the use of the more recent information has appreciably affected the index numbers, since the cut of most kinds of lumber was much smaller in 1919 than in 1909. The revised index numbers for the wholesale prices of all building materials for all years since 1913 are shown in the table which follows:*

[illegible]	201
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	155

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* [illegible]

Index Numbers—1921 and 1922—Original and Revised

The table of index numbers from 1913 to date completely revised in accordance with the preceding explanation has not yet been received at this office, but it is hoped that it will be available for our issue of one month hence. We print herewith figures for May on the revised basis, and such comparative figures as are available for previous months. It is to be noted that not only have revisions been made in the points of quotation and in the items selected, but that the items quoted now total 404 as against 327 on the old basis, while the quantities now used are those for the year 1919 as reported in the census instead of the 1909 quantities previously used.

Year and month	Farm products	Foods	Cloths and clothing	Fuel and lighting	Metals and metal products	Building materials	Chemicals and drugs	House-furnishing goods	Miscellaneous	All commodities
1913:										
Original & revised	100	100	100	100	100	100	100	100	100	100
1921—										
April original	115	[illegible]	186	199	138	203	168	274	154	154
May original	[illegible]	[illegible]	181	194	[illegible]	202	166	262	151	151
1922—										
March original	128	138	182	183	114	202	159	213	153	152
April original	127	[illegible]	181	187	117	201	160	211	152	152
1921—										
April revised	...	...	...	...	...	167	...	...	...	...
May revised	118	[illegible]	[illegible]	200	138	165	134	209	126	145
1922—										
March revised	...	...	...	...	...	155	...	...	...	...
April revised	129	[illegible]	[illegible]	194	113	156	124	175	116	143
May revised	132	138	175	216	119	160	122	176	116	148

Standardized Contracts

Some advantages of standardized contracts for construction were pointed out by Frank M. Gunby of Charles T. Main, Industrial Engineers, Boston, Mass., in an address before the Boston Society of Civil Engineers. Mr. Gunby's remarks follow in part:

A standardized form of contract is desirable. My experience with the administration of the emergency construction contract during the war convinces me that this is so. That contract was used by the Construction Division for its work all over the country, covering a vast range of kind and amount of construction work. Through the use of one standardized contract for all of its work, it was possible to get under way speedily, complete the work at costs for fees which were unusually low, and then to make settlements in practically all cases in a comparatively short time after the end of the job. Compared to the time required to make settlements on similar projects executed under contracts which were not standardized, the records for speed made with the standardized contract were remarkable.

In order to be adopted as a standard, the contract should be fair to both sides, and should be in substantial agreement with existing practices, as, otherwise, the adopted standard will not be commonly used.

Contracts are interpreted by ordinary men and the interpretation is about as important as the wording of the contract itself. For this and many other reasons a contract should be short and simple.

If we are to have a standardized contract, it is important to get as good a standard as practicable adopted after a reasonable amount of discussion and then, if necessary, to make improvements as we go along in practice.

Building Construction in Chicago.—Building permits taken out for the first 15 days of June totaled in round numbers $15,340,000, indicating that the month will smash the high value record established for Chicago in May by more than $3,000,000. The May total of $27,029,650 broke all monthly records in the city's building history. At the same time, property reported to the Citizens Committee to Enforce the Landis Award as being constructed on that basis reached the $75,000,000 mark another high record. The Landis Award construction is of every type from the train concourse and foundations of the new union depot to small bungalows of which one Landis Award contractor has nearly a million dollars' worth under construction.

Unusual Engineering Forces As Design Problems

A Discussion of the Forces Resulting from High Winds, Storm Waves, Ice Packs or Jams, Earthquakes and Geological Changes

By CHARLES EVAN FOWLER,
Consulting Engineer, New York and Detroit

The engineer ordinarily designs his structures to resist the application of common and well known forces, such as the weight of the materials from which the structure is to be built; the live load it is to carry, consisting of people, vehicles or trains, temperature; and ordinary wind pressures. This is usually correct for the average structures, located in protected locations, or where they will not be subjected to extraordinary natural forces. These unusual forces may be covered by the general terms of high winds, storm waves, ice packs or jams, earthquakes, and geological changes.

The unusual or high winds are those of great velocity, beyond 80 miles per hour; the tornado; the monsoon; the typhoon; cyclone; and the hurricane. Storm waves are those produced in rivers, lakes, estuaries, and oceans by high winds up to 80 miles per hour and beyond. Ice packs or jams are produced by the pressure of great fields of ice, or the great jams formed by the breaking up of sheet ice and its piling up in channels or straits by currents, winds, and waves. The earthquake, while given a separate classification, is in reality one of the most destructive of geological forces, being caused by the sudden readjustment of the earth's crust. Geological forces as ordinarily classified are the scouring due to currents and waves, and the changes in cliffs and strata due to disintegration from various causes.

Wind Pressure.—The usual wind pressure considered in designing ordinary structures is 30 lbs. per square foot, or that caused by a wind having a velocity 80 miles per hour or less. Winds having velocities of 50 miles per hour are considered hard storms, those of 55 to 75 miles very hard storms, and those beyond this as tornadoes, monsoons, typhoons, cyclones, and hurricanes. Tornadoes are very severe inland storms; severe sea storms are termed cyclones or hurricanes in the Carribean Sea and Gulf of Mexico territory, cyclones or monsoons in the Indian Ocean, and cyclones or typhoons in the Western Pacific Ocean.

The formula long used in calculating wind pressure from the velocity is that of Smeaton propounded in 1759, $P = 0.005\,V^2$, in which P is the pressure in pounds per square foot and V is the velocity in miles per hour. Due to the fact it gives somewhat higher values than modern more exact formulas, it is the proper one to use where the engineer prefers to provide for contingencies or to have results on the side of safety. The more exact formula of the United States Weather Bureau is $P = 0.004\,\frac{B}{30}\,V^2$, in which P and V are as above, and B the barometric reading in inches; and becomes $P = 0.004\,V^2$ for a barometric value of 30.0 in. Where the barometer reading was 28.15 in the terrific hurricane of September 1915 on the Gulf of Mexico, the formula would resolve into $P = 0.00375\,V^2$, and with the maximum wind velocity of 140 miles per hour, would give a pressure of 74 lbs. per square foot. The Smeaton formula would give 98 lbs. per square foot for the same velocity, or provide to some extent for the probable impact of sudden gusts of such high velocity.

The pressure gages used for recording wind pressures at the Forth Bridge in Scotland, gave a maximum of 41 lbs. per square foot, although 56 lbs. was the value used in designing, which was also the same as was used for the Firth of Tay bridge as redesigned and rebuilt after the blowing down of the original structure. The wind velocity or gust of 140 miles per hour at Burwood, La., in the September 1915 hurricane is probably as great as has occurred anywhere in the world. The steady blow did not exceed 128 miles per hour. The highest velocity recorded off the Pacific Northwest Coast is 90 miles per hour, and at Detroit, Mich., 87 miles per hour. The writer used a velocity of 125 miles per hour in calculating this eccentric pressure on the foundations for the Tacoma Smelter Chimney of about 600 ft. height, at Tacoma, Wash., to provide against sudden gusts, and about the same value was used for a large chimney in Montana. The conclusion most logical and undoubtedly safe, is to assume a maximum velocity of 125 miles per hour for the most lofty structures or for very important structures, in the most exposed localities. The high values for some of the most severe of the hurricanes on the Gulf of Mexico are.

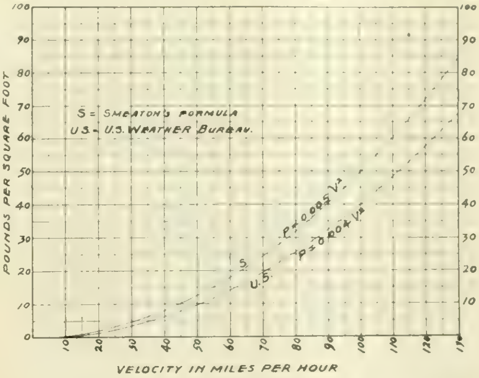

Fig. 1.—Comparison of Smeaton's and U. S. Weather Bureau Formulas for Wind Pressure from Velocity.

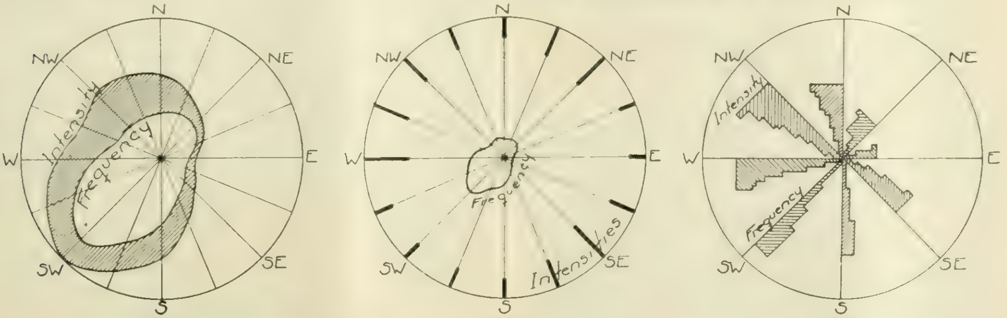

FIG.2 FIG 3 FIG.4

Figs. 2, 3 and 4.—Three Methods of Plotting Records of Prevailing Direction and Intensity of Winds.

		[illegible]	[illegible]	U.S.W.B.
[illegible]	[illegible]	[illegible]	Lbs.	Lbs.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	41	30
[illegible]	[illegible]	[illegible]	58	74
[illegible]	[illegible]	[illegible]	[illegible]	40
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1919	Corpus Christi	[illegible]	[illegible]	24

The following classification [illegible] is taken from the Beaufort Scale for Winds.

		Velocity, miles per hour
[illegible]	[illegible]	0
[illegible]	light air	[illegible]
[illegible]	light breeze	[illegible]
[illegible]	gentle breeze	[illegible]
[illegible]	moderate breeze	[illegible]
[illegible]	fresh breeze	[illegible]
[illegible]	strong breeze	[illegible]
[illegible]	moderate gale	[illegible]
[illegible]	fresh gale	56
[illegible]	strong gale	[illegible]
[illegible]	whole gale	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

The records made at any harbor as to the prevailing direction and intensity of winds may be plotted in one of the three forms shown as Figs. 2, 3 and 4. Figure 2 shows how the frequency ordinates may be set off from the center and the intensity ordinates then set off from this frequency curve. Figure 3 shows the method of setting off the frequency ordinates from the center and the maximum intensity ordinates from the circumference, the frequency ordinates being connected in a curve as in the first diagram and the intensity ordinates shown by heavy lines. Figure 4 has the frequency ordinates set off from the center and the intensity ordinates in radial lines. Each method has its advantages, but either one shows the record plainly.

The design of any structure to withstand such high wind pressures must be most seriously studied. The relative resistance offered by various shaped pieces used for structures, assuming a flat plate is 100, is for a square member 95 percent, for a square member cornerwise .79; for a circular member .57; for a diamond with thin edge to wind .25; for a triangular member with face to wind .71, with apex to wind .42 and with base parallel to wind .59; for a sphere .36; and a 60 degree cone 54 percent. Where two circular plates of 2 in. diameter were separated 1.5 diameters apart the total pressure was only 75 percent of that for one plate; at 2.15 diameters apart it was equal to the pressure on one plate; while at 5 diameters it was 1.78 times the pressure on one plate.

The area presented to the wind by a riveted 300 ft. span truss bridge of usual design, would be about 22.7 sq. ft. per lineal foot of bridge, considering the pressure on the leeward truss as eight tenths that on the windward truss. However by designing such a length span with circular top chords and [illegible] eye bar bottom chords, and lattice floor beams and stringers, the area per lineal foot of span would be cut to 10.7 sq. ft. or a reduction of over 50 percent. This is near the theoretical extreme of possible results, but is an indication as to how thought can be profitably expended.

Wave Pressure. The pressure of waves may be due to waves of translation near a shore, or to oscillatory waves off shore where only one-half of the energy is transmitted forward with the wave form, and may affect such structures as light houses built some distance from shore, with a force as great as from [illegible] to [illegible] lbs. per square foot. The greatest force recorded by Stevenson was 6083 lbs. near Tyree Island on the Scottish coast. The calculated effect of a wave 42 ft. high and [illegible] ft. long is [illegible] lbs. per square foot but waves have been reported much in excess of this. The height of waves in the Mediterranean is from 15 to 20 ft.; in the Bay of Biscay 25 to 30 ft.; in the Pacific from 50 to 60 ft. maximum, and about the same in the Atlantic or up to 50 ft. in the North Atlantic in 1922; and earthquake waves up to 80 ft. in height although some of this was most likely from the dash or break of the wave. Waves will dash up to a height of about [illegible] ft. on rocks or such structures as lighthouses.

Waves of translation which affect harbor and shore structures were discovered by J. Scott Russell, the English authority, about [illegible]. When oscillatory waves reach shallow water they are transformed into waves of translation, where all the water particles move forward and none backward.

The [illegible] at Corpus Christi in 1919 taught that the [illegible] that the hurricane waves spent their force on Mustang Island and the other low islands about 15 miles out, was erroneous, and that with a storm tide of nearly 13 ft., carrying waves of translation on its crest, even for the short fetch of 15 or 16 miles across the very shallow bay, the waves reached a height of from 10 ft. to 12 ft! Such waves may strike a maximum blow of from 3000 to 4000 lb. per square foot. Their great velocity and destructiveness has caused writers to describe their combined action as a tidal wave! The writer doubts if a true or real tidal wave has ever occurred during any of the Gulf hurricanes. The fact can be positively stated that such low barrier islands and shallow waters as occur off Corpus Christi and other Gulf localities are not a protection that can be depended upon.

The waves off the open shore at Peterhead in North Britain are also evidently transformed into waves of translation, as on Feb. 15 and 16, 1900, with a wind of from 50 to 89 miles per hour and in water only from 60 to 65 ft. deep, the waves rose to a height of 22.5 ft. above still water level, or a total wave height of over 30 ft., possibly over 40 ft.

The writer, on Dec. 14, 1920, was crossing the Detroit River by ferry at 10 o'clock a. m., and found a very high wind blowing directly up the river at the time, and very high waves running in about 40 ft. of water and with a fetch of only between 2 and 3 miles. The velocity of the wind was found by a visit to the Weather Bureau afterwards, to have been 54 miles per hour, and waves were observed on the sides of a scow being towed in midstream, of from 6 ft. in height to over 7 ft. Upon my return at 12:00 noon the wind velocity had increased to 60 miles per hour, and waves were observed from 7 ft. to 8 ft. high, which height was verified by an engineer associate along with me. It is interesting to note that the writer weighing 200 lbs. could just walk against the 60 mile wind, and that he saw a lady blown off her feet.

The account of the Sept. 29, 1915 hurricane speaks of swells of from 10 to 12 ft. running on the Mississippi River. Russell records that he never saw waves 10 ft. high in 10 ft. of water, nor 20 ft. high in 20 ft. of water, although he had seen waves approach very nearly to those limits.

The observations of many observers as recorded by Johnson lead him to say that when waves run into shallow water they seem to awaken into new life, crowding closer together and increasing in height until they break; likewise waves running against a current increase in height. Such waves of translation transmit forward their full energy, while as stated only one-half of the energy is so transmitted by oscillatory waves.

The highest recorded storm tide on the Gulf Coast was of 16 ft. in 1919 near Corpus Christi; one of 9.8 ft. in Lake Borgne near the Rigolets or the entrance to Lake Pontchartrain, and one of 13 ft. near Frenier at the western end of Pontchartrain. The amount of water that passed in and out of Pontchartrain, must have amounted to nearly 90 billion cubic feet! The great maximum velocity of this is evidenced by the way in which it tears out great areas of the marshes. The height to which structures must be raised to clear such maximum storm tides as 16 ft., carrying wave crests 9 ft. above such level, is thus clearly shown, and if such a clearance is impossible, then as stated, the design of structures must be such as to largely nullify the wave force.

The force of waves of translation may be expended against sea walls, breakwaters, or piers in two ways, by the resultant direct pressure against a flat surface; or partly by direct pressure and partly by the impact from the splash of the wave. The diagram Fig. 5 shows the wave force obtained by dynomometer readings at Negropoint breakwater, St. John, Canada. The maximum observed pressure was 4000 lbs. per square foot, with the storm tide at the level of the dynomometer. The computed height of the wave was 12 ft., the assumed center of pressure was 1 ft. above L.W. storm tide or 3.2 ft. above H.W. O.S.T., and the assumed pressure of the storm wave per lineal foot of the wall 40,000 lbs.

The force of a dashing wave is given by Prof. Luiggi, the eminent Italian authority, in the following data as derived from observations. These were made on waves from 19.5 to 22.75 ft. in height and dashing in jets up to 65 ft. high.

Below sea level	32.25 ft.	[illegible] lbs.
Below sea level	19.5 ft.	[illegible] lbs.
Below sea level	13.0 ft.	[illegible] lbs.
Sea level	0.0 ft.	[illegible] lbs.
Above sea level	13.0 ft.	[illegible] lbs.
Above sea level	32.25 ft. =	4,250 lbs.

This type of wave force is shown graphically in Fig. 6 by the solid line, or for a 40 ft. dashing wave, while the dotted line gives values for a 15 ft. dashing wave as plotted by comparison.

The height of waves may be computed from the formula:

$$\text{Height} = 1.5 \sqrt{F} + (2.5 - \sqrt[4]{F})$$

in which F is the fetch for short distance wind action in nautical miles. The following list gives a comparison of observed and computed values:

Location.	F in n	Observed	Calculated, ft
Scalpa Flow	1.0	4.0	3.0
Firth of Forth	1.3	1.8	3.2
Detroit River*	3.0	[illegible]	3.8
Clyde River	9.0	4.0	[illegible]
Lough Foyle	11.0	[illegible]	[illegible]
Corpus Christi‡	16.0	[illegible]	6.5
Anstruther	24.0	6.5	7.7

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*Against river current.
‡Increased by hurricane.

This formula is shown graphically in Fig. 7, but under actual conditions that may exist, the values shown may be exceeded by from 25 to 50 percent, as noted for Scalpa Flow, Detroit, and Corpus Christi. The actual values for any given locality may have been recorded, or it may be possible to make records previous to the designing of the structure; but if the calculated value must be used, then the structure must have a factor of safety great enough to provide for a force at least 50 percent greater than the calculated one.

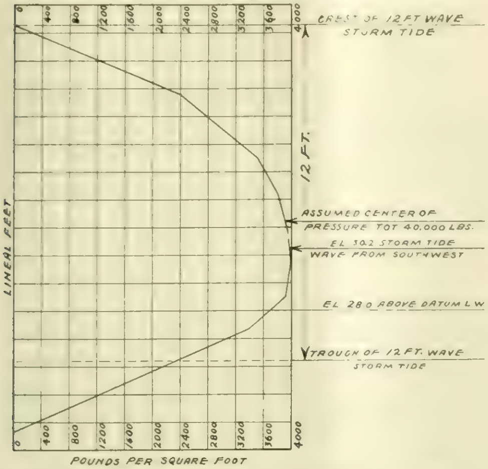


Fig. 5.—Pressure Record of Waves at Negropoint Breakwater.

The form of the structure is most important in that it must offer the least possible resistance to the waves. The Galveston sea wall is an example of this, but in making a curved face there must be a reverse curve at the top, so that the water will not dash up vertically and cause damage by the drop of the tons of water falling. Likewise there must be no joints or horizontal offsets or the lifting force of the wave must be accounted for in designing. The design of bridge piers to resist waves must be such as to offer small resistance, and while a cut-water formed by arcs of circles on an equilateral triangle is good, a pier of elliptical cross section is better. Sea walls may be so designed as to cause the water from a wave to fall back practically dead, and protective devices may be used for the protection of bridge piers and other structures.

Ice Pressure.—The pressure of ice jams in rivers, straits, estuaries, or often the pressure of ice packs must be taken account of in designing engineering structures. The pressure of moving ice in rivers where ice is likely or sure to run, may be ordinarily taken at 300 lbs. per square inch, but on the St. Louis bridge it was figured at 600 lbs. per square inch on the area estimated to be covered by the crushing ice. The ice may jam down to the bed of the river, so that the resultant pressure from ice jams or even log jams will probably be that due to the hydrostatic pressure on a bridge pier and half spans on either side, from the hydrostatic head due to the difference in the elevation of the water above and below the bridge.

The specifications for highway bridges of the Ohio Highway Department, considers "the force of floating ice upon structures subject to it, shall be taken as 30 tons per foot of width exposed, as measured at right angles to the direction of flow. It shall be taken as acting at an elevation above low water stage equal to at least two-thirds of the difference between high and low water." Where the ice conditions are very severe, it is more than likely that it will be difficult to arrive at any exact basis for calculations, and the judgment of the engineer must govern. However it is unlikely that in any case it will be necessary to exceed the provisions of the piers constructed for the Victoria bridge at Montreal, by Robert Stephenson, which have withstood the most severe ice pressures of over 60 years. The safe method is to consider the pressure as acting at the level of high water, as ice usually goes out on a big rise in the river.

The pressure from ice packs or great crowding fields of ice has never been recorded, but from moving pictures showing ships being forced vertically upwards by the wedging action on the bottom slope or dead rise of a vessel, it is fair to assume the pressure to be much greater than for an ice jam. Assuming the force of the couple gripping the ship to be that from a vise like action over a height of 20 ft. of the sides of the ship, we must conclude that the force may reach double that previously stated or 1,200 lb. per square inch. Such action may occur in the case of bridge piers for bridges across lakes or bays, or similar isolated structures, but not in the case of sea walls or breakwaters.

Earthquakes.—The destructive force from earthquakes may be that from the quake itself, or from a resultant tidal wave on the adjacent ocean, in which case the preceding discussion as to wave force would apply. The earthquake consists of a wave action of the earth's crust accompanied by more or less of a twisting motion. The force of such twisting or torsion is small and may be disregarded in a well designed structure. The wave being of great length, its vertical action is comparatively small as well, but is destructive enough to break lines of water pipe, tunnels, or other structures crossing fault lines. Where it is absolutely necessary to cross a fault, then the structure must be so designed as to either make breakage unlikely, and in event of a break, easy to repair, temporarily at least.

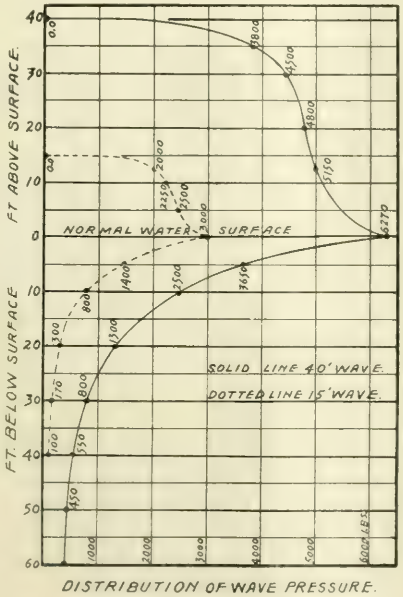


Fig. 6.—Distribution of Pressure of Dashing Waves.

The most destructive feature of earthquakes is the horizontal motion or rapid oscillation, and anyone who has been through one knows the "feel" of this, and the effect from hearing window heights hammer back and forth. The resultant effect on a structure is similar to that from wind, and it is possible that any structure designed for a full wind load will withstand quite severe earthquake shocks. However, the stresses are very much greater than from a force acting in one direction, due to the very quick reversal. The structure should be made of highly elastic material and design, and as light as possible, especially in the upper portions, and no heavy or concentrated weights should be placed there. Heavy concentrated foundations are best, and the structure must be firmly and completely anchored to them in an elastic manner.

The investigation of a [illegible] suspension bridge with towers about 300 ft. high showed that the increase of stresses from a heavy shock would not be dangerous in any member, but that the details of construction required special design throughout. This was on the basis of a shock having an amplitude of 2 in. giving a maximum acceleration of 10 ft. per second per second and a lateral force equal to 2.59 per cent of the weight of the structure. The horizontal shear at the base of the tower was found to be less than half that due to wind load, and the uplift on the windward side only about 11 per cent of the dead load reaction.

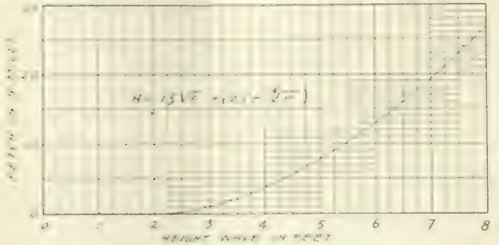


Fig. 7.—Height of Waves for Short Fetch.

Geological Forces. The natural changes of a foundation bed for piers in a river due to the scouring out of the bottom may prove to be a very dangerous matter, and can only be foreseen by a careful study of records if they exist, or by a series of borings at intervals so that the geological cross section can be completed and the lowest stable stratum determined. Should the bed of the stream scour deeply, most of the allowance that might have been made from skin friction on the pier would be nullified, water might get under the bottom of the pier and cause a dangerous uplift, especially when combined with the greater overturning forces that would act on the pier in the deeper water. The filling in of dredged channels or harbor basins, due to the solid material carried into them by rivers may easily result in their obliteration practically or in a financial way. Rivers that are used as ship channels may fill up so rapidly as to make the cost of continual dredging prohibitive.

The currents induced by winds and waves in the mouths of rivers or estuaries may become of very serious concern, in causing the scouring out of foundations for piers, seawalls, or other structures.

The currents in estuaries during a hurricane have, so far as known to the writer, never been measured, but it is fair to assume that at least the surface current as partly generated by the wind and waves of translation, when added to the usual currents, will have an exceedingly high velocity. While the ordinary tidal currents in channels at various points along the Gulf Coast may have only a maximum value of from 4 to 5 miles per hour near the surface, it is quite certain that the combined surface velocity may reach as high as 12 to 15 miles per hour during a wind of a velocity exceeding 100 miles per hour. The surface disturbance from waves reach to depths of water of 50 ft. or greater, and the combined current as above will have a velocity at similar depths that will cause serious scouring effects in channels having ordinary material for the stream bed. Thus by observations as to the sizes of material scoured out, we can easily fix the velocity at the bottom of any channel, and it will in the majority of cases probably be found less than 4 miles per hour in ordinary channels from 10 to 40 ft. deep. This would cause movement of sand but very little heavy gravel. The reduction of ordinary current velocity from near the surface to the bottom of a river has the shape of the curve of a convex [illegible], but the reduction of velocity from the surface to the bottom of a tidal current through a [illegible] would undoubtedly [illegible] the curve of a concave parabola, due to the banking up of the swiftly moving water against the slower moving or comparatively slack water of the ordinary flow.

The changes in shorelines, beaches, cliffs, headlands, and the like by ocean waves are of too intricate a nature to discuss in a few paragraphs, but the engineer having to do with ocean or harbor structures, should read "Shore Processes and Shoreline Development" by D. W. Johnson from cover to cover. The suddenness with which such changes may come about is illustrated in a statement by Kinahan, that at one point on the Irish coast a beach 600 ft. wide was created during the spring of 1876, in front of a cliff on the coast, where there was deep water the preceding winter. Austen says in regard to the southern coast of England that "during the first few hours of a gale, enough material may be removed from the shore face to deepen the water there from 5 to 10 ft., especially where a sea wall helps to concentrate the wave energy along a narrow zone." Along the Chesil Bank a single storm has removed 3,763,300 tons of shingle from the beach.

"In the preceding paragraphs I (Johnson) have endeavored to give the reader some idea of the serious difficulties which confront the student of shore processes. It must be confessed, however, that it is much easier to describe the complexities of currents, and to point out the mistakes which are frequently made in interpreting them, than it is to solve those complexities in a given case and present a discussion which is so conclusive as not to be open to criticism. Nevertheless, it was essential that we should enter upon our treatment of shoreline forms with a broad view of the problems connected with wave and current action, and with some appreciation of the variety of the forces which operate at the shore in different places and at different times. We are now prepared to consider the development of shore lines more intelligently, even if we are not prepared to assert with positiveness the precise part played by different currents in shaping each portion of any given shore."

"The time will come when our present limited knowledge of both wave and current action will be enormously extended by means of improved mechanical appliances. The movements of debris upon the bottom at considerable depths during wave action, concerning which we can only theorize at present, will be actually observed by special electrical apparatus. Wave currents and currents of other types will be studied by observing the exact movements of debris under their control. Limited areas of the coastal waters will be exhaustively studied, every detail of the currents analyzed with care under varying conditions, and the movements of debris determined with far greater precision than is now possible. While shoreline problems will never be simple, the researches of the future will yield a body of facts which will enable the geologist and engineer of some coming generation to predict shore changes and plan harbor and coast defenses with an assurance which will contradict the assertion of the present maritime engineer, that the forces operating at the shore are among the forces of nature, "which are subject to no calculation." In the meantime we may take some satisfaction from the fact, which will presently appear, that a great deal may be learned about current action by studying the forms of beaches, since these often provide a more reliable indication of the dominant currents in a given locality than do any direct observations feasible at the present time."—(Johnson.)

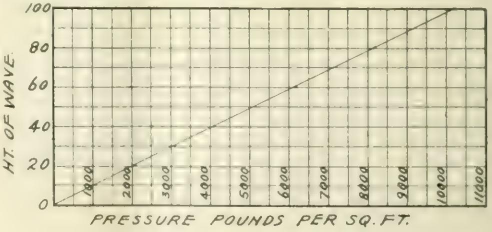


Fig. 8.—Pressure of Waves.

The danger from high overhanging cliffs is well illustrated at Niagara Gorge. Below the Whirlpool the overhang has largely broken off and fallen to the bottom so that the tens of thousands of tons of huge boulders have acted in the nature of a gigantic riprapping, and the high banks have thus reached an angle of repose. The cliffs above the Whirlpool on the other hand have had more human interference and protection, so that the huge boulders are largely absent, and the river channel is scouring wider and deeper. The dangerous overhang has been and is being continually removed as a protection to the Gorge Railway; and a similar removal was done at the Railway Arch Bridge by the writer in 1919, in response to warnings of some slight falls which should they have been large in extent might have endangered the structure. Some large falls on the Gorge Railway have stopped traffic for from one to two weeks.

The complex series of spits and bars composing Nantasket Beach on the Massachusetts coast, show that "the phenomenon of a shifting fulcrum between a retrograding cliff and a prograding beach plain may occupy an important place in the history of a shore line."

"Continued wave erosion soon pushes the notch so far into the land that the unsupported overhanging rock falls down under the influence of the forces of weathering, including the action of gravity and rain wash on the face of the slope. This produces the wave-cut cliff, in front of which is the wave-cut rock terrace called the bench. The eroded debris will be added to the submarine talus if the shoreface slope is steep enough and the water deep enough, except such part as is ground sufficiently fine to be widely distributed over the sea-bottom far offshore. If the water is shallow or the slope gentle, a shoreface terrace may be formed at this time." —(Johnson.)

Conclusions.—The engineer in dealing with any of the problems of design arising from the necessity of having to build a structure subject to such unusual engineering forces, has two sources open to him. First, to design the structure along usual lines, of sufficient strength to withstand the maximum probable or known unusual forces; or second, to so design the structure that it will offer less surface to the unusual forces, or else a minimum chance of having to resist such forces.

Where it is possible to follow the second method and make the structure of special design, but along proper theoretical and practical lines, so that it will minimize the effect of the forces, this is without any question the method to pursue, both from motives of good engineering and economy. However, when the engineer after the most careful study has exhausted all possible hopes for such a special design, then the only thing is to design the structure along usual engineering lines, but of sufficient strength to withstand all the maximum forces, and to some extent regardless of cost.

Should the maximum forces of every kind be absolutely known, then it will be permissible to allow unit stresses for a maximum possible combination of all forces, that are only safely within the elastic limit of the material; or where the forces of stability are in excess of those of destruction. Each case must most emphatically be made a special problem, and all that has or might be written should be no more than a guide to its solution.

Testing for Vibration in Buildings.—An ingenious method of ascertaining the vibration in a building is described as follows by J. R. Linton of Sioux City, Ia., in a recent issue of Popular Mechanics:

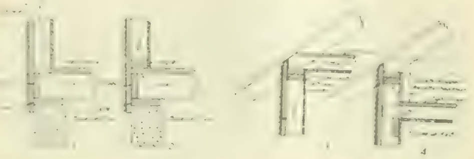
In a western city, a reinforced-concrete building had but recently been completed when the plastering began to fall from the ceilings. The owner claimed that work was not according to specifications, and the contractor asserted that the trouble was the result of vibrations, which were caused by trolley cars crossing a frog in the street just in front of the building. As none of the vibrations were heavy enough to be seen or felt in the four-story building, an engineer solved the problem and traced down the trouble in a novel manner. A shallow bowl of metallic mercury was placed on the floor of the top story, in such a manner that the mercury would be in direct sunlight. Those interested in the result of the test stationed themselves at a window and watched. A reflection from the sun was thrown onto the ceiling by the mercury and as the street cars passed, it was noticed that the reflection on the ceiling moved several inches, thus greatly magnifying the movement of the building and vindicating the contractor.

How to Prevent Heat Losses in Small Houses

That the ordinary type of small house can be made just as resistive to the loss of heat as can any other building and at a very small additional cost, was pointed out by J. D. Hoffman, Professor of Practical Mechanics at Purdue University, in a paper presented April 5 at the National Construction Conference in Chicago. An abstract of the paper follows:

"In the average frame house, it is usually the practice to have only ½ in. of lath and plaster separating the room space from the space between the studs. Lath and plaster is a very poor insulator, as it is porous, and the heat from the room easily goes through this material and enters the space between the studs, only to be carried to the attic by convection, or to be passed through the sheathing to the outside air.

The effect of this air movement through the walls and partitions can be easily observed on any old plaster wall and ceiling. The dust carried by the air currents will have penetrated the plaster between the lath, and left a series of dark streaks upon the plaster and the wall paper.



Details Showing Methods of Preventing Heat Losses in Small Houses.

(1) Shows how an air space is normally left between the studs and how air is carried by convection through this space from the basement to the attic, carrying the heat to the outside air. It also shows how to stop up the space between the studs with a filler block at the floor level, which may be used in both old and new jobs. (2) Details to be used in new construction. The flooring is laid all around to the sheathing, and studs are set on plates resting upon the floor. (3) Recommended detail for closing all air spaces between the studs and joists at the ceiling. (4) Detail for insulating the upper floor where the joists are dropped below the eaves to afford room space in the attic. The open spaces A and B should be closed up with tight sheathing and a perfectly tight floor laid. A good wall board can be used to cut off space A.

How to Prevent Interior Air Movement.—Many buildings are constructed with this hollow space within the studs opening up directly into the basement space. Such construction is extremely bad, and it should be corrected. In old buildings, where the studs extend to the plate, and the floor meets the inside edge of the studs, this space is probably open. The only way to remedy this error is to insert filler blocks between the studs on the level with the floor. In new construction, it is best to floor over the entire first floor or subfloor between the sheathing, on all sides, and set the studs upon a plate placed upon this floor. This will effectively cut off all air communication between the basement and the stud spaces. In attics, where the joists are laid upon the rafter plates, these spaces are usually cut off; but in attics where the floor is lowered to obtain head room, the spaces between the joists and between the studs must be closed with tight sheathing, as shown in the diagram. It is important to make sure that all stud spaces are tightly closed at top and bottom. This process is often known as fire stopping.

The Exterior Finish.—For the exterior finish provide straight, solid boards, with ship-lap or tongue-and-groove joints, and see that they are well laid. A good grade of building paper should be placed underneath the sheathing, also between the studs and inside lath and plaster. The best application of the latter is to nail the building paper onto the studs and then attach the lath to furring strips over the paper.

Pieces of studding material, commonly called "fire-blocks," should be nailed between the studs at a point midway between the first and second floors, to still further reduce convection. This treatment will also tend to decrease the fire hazard of the building.

One of the worst conditions to meet is the bungalow with one or two second story rooms. These upper rooms are frequently hard to heat and special precautions should be taken in the design of the structure. The principal difficulty lies with the attic spaces beside and above these rooms. Usually no attempt is made to floor over these spaces, and it is often found that the heat losses in this type of house are greater than in a 2-story building. It is necessary to floor over all such sections with some type of insulating material. This is a good place to use wall board.

Summary. Cut off all spaces between the studding, from the basement and the attic.

Insulate all outer walls with good shiplap or tongue-and-groove siding, well laid.

Always use a good quality of building paper over the sheathing.

One layer of building paper laid over the inside of the studs is recommended.

Floor over all attic spaces with a tight floor.

Sheath with shiplap or wall board, or other equivalent, over all studded walls between upper floor rooms and attic space.

Insulate all floors that come in contact with cold aid, where these rooms are to be used for other than sleeping porches.

Freight Rates on Sand and Gravel Reduced in Michigan

The Michigan Public Utilities Commission has just handed down two decisions on an action brought by the Michigan Sand & Gravel Producers' Association for a modification of the order of the Commission which went into effect in May, 1921. The new decision reduces the Michigan mileage scale an average of 17 per cent, and also reduces the carload weight from 100 per cent to 90 per cent of the capacity of the car. Taken in connection with the reductions ordered into effect a year ago, this order will reduce the rates on sand and gravel in Michigan to or below the basis in effect prior to the increase of Aug. 26, 1920. The new rates in Michigan, which are to be effective July 1, assuming, of course, that action is not taken by the railroads either before the Interstate Commerce Commission or Michigan courts to suspend the Commission's order, are as follows:

MICHIGAN MILEAGE SCALE ON SAND AND GRAVEL

Miles	Cents
10	50
15 and over 10	54
20 and over 15	58
25 and over 20	62
30 and over 25	66
40 and over 30	70
50 and over 40	75
60 and over 50	80
70 and over 60	85
85 and over 70	90
100 and over 85	95

Extra for 2 line, 12 ct., and for 3 line, 20 ct. per ton. Minimum weight 90 per cent of capacity of car.

Appraisal Schedule of Detroit Real Estate Board

In a recent issue of The Constructor, F. S. Robinson, Secretary, General Builders' Association of Detroit, gives the following information regarding the appraisal of buildings:

In fire loss cases generally the firm that makes the appraisal is the one that does the repair work and the fee, if any, is absorbed in the work. The only definite fee of which I could learn is that of a firm of contractors, and they were not sure that it was on condemnation proceedings. This fee amounted to 1½ per cent of the value of the building. Where complete estimate of quantities and value is made I would think that it should be double that.

The following is a copy of charges for appraisals by members of the Detroit Real Estate Board.

For making valuations on real estate, members shall not charge, when a charge is made, less than the following amounts:

On amounts up to $5,000	$25
On amounts over $5,000 and under $15,000	50

On amounts of $15,000 and upwards, charge $50 on the first $15,000 and $1 per thousand on the excess up to $300,000 and 75 cents per thousand on the excess from $300,000 to $500,000, with a further charge of 50 cents per thousand on excess over $500,000."

The above are the minimum fees to be charged for ordinary valuation service, but where a member is called upon to render special valuation, he may use his own judgment as to the amount of his fees, but they shall in no case be less than the amounts hereinbefore set forth.

"A fee of at least $5 shall be charged for each description. Minimum charge for attendance at court, $10, payable in advance."

Business Buildings Designed in Three Dimensions

In an article "A New Type of American Architecture," in The Improvement Bulletin, Rollin C. Chapin, architect, expresses his views as follows on the new type of skyscraper now being erected in New York City:

"Probably no one who has visited New York City during the past year or two has failed to notice a new type of skyscraper has come into being. Instead of the cut-and-dried 'scraper to which we have been so long accustomed, with its 20 to 40 stories of facade rising unbroken from the street and crowned by a huge projecting cornice, we observe that these newer buildings begin to step back from the building line at a certain height, something in the manner of superimposed blocks of diminishing sizes. These tower-like upper stories are treated in interesting variety, not one side only, but all four as a unit, and the great ugly cornice is conspicuously lacking. What a relief to at last see business buildings designed in three dimensions!

"This new type of building is the result of New York's new zoning law. This law, broadly stated, operates in two ways to bring about a more harmonious development of the city. First, by its 'use regulations,' it segregates the manufacturing plants from the retail sections and both from the residence districts. Second, by its 'height regulations,' it divides the city into districts in each of which the allowable height of the street facade has a definite relation to the width of the street, varying from street width to two and one-half times the street width. This limit is not, however, on the total height of the building, but on the vertical height at the building line. Above that limit buildings may be extended to a height limited only by economical considerations, but the portions above the limiting height must not extend beyond a diagonal line drawn through the center of the street and the limiting height at the street line. Other provisions affect the height on the rears, on courts, side streets, etc. In a general way, this means that above the height limit all buildings must be contained within a pyramid whose sides have a slope of about 75 degrees. Therefore, a large building may rise to considerable height above the facade height limit, while a smaller building cannot economically be built much higher than that limit.

"It will be seen that this law has given the architect a new problem. He must use greater skill in planning in order to make it economically desirable to build to great heights, and at the same time he is given almost unlimited scope to his imagination in designing in three dimensions.

"While not a great number of buildings have been erected since this law was passed, the few that have been built are so satisfactory, both economically and aesthetically, as to fully justify the law. A notable example is the Heckscher Building near Columbus Circle, designed by Warren & Wetmore.

"To the writer it seems that this style of tall building is destined to become the prototype for all American cities. The idea could be applied on a smaller scale to our moderate-sized cities. We need some remedy for the oft-repeated crime of treating architecturally only the street facades of our buildings, and allowing the other sides, perhaps more conspicuous than the embellished one, to glare at us with their bare common brick surfaces, ugly signs, and what-not. Some such regulation as New York's would help to answer this need, and would do much to beautify our business sections."

A Cheap Board for Large Drawings.—The high price of a large drawing board and the still higher price demanded for a large-size drawing table are items that must be seriously considered when the board is required only for some special piece of work, writes C. Nye in Popular Mechanics. An idea that represents an economical and practical solution makes use of a variety of wallboard that can be optained in panels of almost any dimensions up to 4 to 12 ft. The type of wallboard best suited for the purpose is that which is built up of wooden strips, cemented together to make a continuous board, with a smooth surface of tough brown paper. The cost of this material is but a few cents per square foot. Wall-board of this kind is made ¼ in. thick, and the large panels are therefore flexible and should be well supported when used horizontally; when used vertically, this is unnecessary. A standard ¼-in. metal channel, fitted to the edges of the board, makes a fine sliding edge for the T-square.

Garden Cities and Model Dwellings as Conceived by the French

A Remarkable Reconstruction Effort Achieved by the French Northern Railway Company

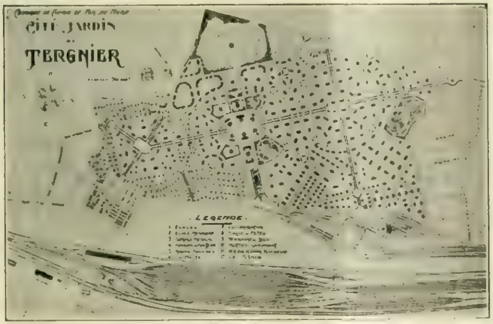
By W. P. MITCHELL
15 Rue Delambre, Paris, France

The name of the inventor of garden cities and model dwellings is lost in oblivion, though the date is not so very far remote. With the rapid march of events during the years of war in Europe and since we and ideas have aged considerably.

Soap and sewing machine makers and cocoa manufacturers have vied with each other in advertising features born of the garden city idea, almost always to the financial benefit of their stockholders quite as much as to the well being of their employes.

In a measure all these efforts have succeeded, in the United States, in Great Britain, in Switzerland, in Holland, in Germany, in Italy even, but it has remained for a railway company in France to first tackle the housing problem of its employees on a grand scale.

A Great Railroad Project.—The Chemin de Fer du Nord, the Northern Ry. Co., of France, has conceived a whole battery of garden cities flanking its ravaged line which came forth from the war as but a mere skeleton of what it once was. This railway is the chief instigator of the garden city movement in France. French ingenuity and taste have accomplished wonders without in any very great measure foregoing the traditions which have done so much to make France what it is today. Nowhere is a man's house more his castle than in republican France.



Plan on Which Tergnier Is Being Rebuilt.

From Armistice Day to 1922.—On Armistice Day, Nov. 11, 1918, throughout a length of 2,123 kilometers of this railway there did not exist a single station building, a locomotive roundhouse, a car-shed, bridge or culvert, not a kilometer even of solid roadbed, or a single dwelling in which to house the employees who were to put things in order.

Since that day the company has done the impossible, as the French have it, to reconstruct the line, a fundamental element for the re-establishment of a normal active life throughout its district. For its accomplishment a large staff was necessary, the first problem of all to follow being that of housing and feeding them and their families, and this amid a devastation as bare and arid as a desert. A permanent shelter was deemed, and rightly, the first requirement of an established civilization.

Since 1919 the company has obtained, from the French Ministry of Public Works, the authorization to realize several successive projects for housing its employees in these reclaimed districts. The soil was virgin, practically nothing more than clearing was required, practically nothing remained of a former debris which might be incorporated into new structures.

The first houses were scattered here and there along the line following the timely needs of the service, as often as possible being grouped as a nucleus of what later would be developed into a garden city community—something difficult of conception at first thought for a great railway junction like Tergnier and still more so of a big coal mining community like Lens.

Types of Houses.—Most of the wooden houses first built were four roomed. Contrary to what is applicable to most of France, families are large in the north. These houses have a general living room and a kitchen, a room for the parents and one each for the boys and girls.

These first houses were more or less of the knock-down order, roofed with rubberoid and later with tiles. In general, they were all lighted with electricity and their doubled walls served as a satisfactory method of insulation against the cold and damp of this rather humid region of north France where they were all located.

The Docthor's House, Tergnier.

In 1920 the program for the construction of wooden houses was considerably enlarged in spite of the opposition throughout Europe, even in England, against the wooden house per se as being something neither durable nor efficient against cold and storm. The marvel is in this respect that old Europe has not taken a leaf from the book of American experience. Up to Jan. 1, 1920, there had been built 2,600 houses of this nature; up to July 1, 1921, 3,765, and up to the first of January, 1921, 4,700. The continual rise in the prices of building materials, especially wood work, made it evident that cement and brick built edifices might better serve the need and the possibility of rapid and economical construction at this time.

The first cement constructed houses were put in hand in July, 1919, to the number of 160. These were at Tergnier and Ailly-sur-Noye. By the first of April, 1921, there were 1,551 such houses already occupied and by the end of October of the present year (1921) the total will number 6,054 individual dwellings.

School House, Tergnier.

The average apartment is composed of four rooms with a porch, cellar and toilet. The apartments for large families are of five or six rooms, these numbering about 10 per cent of the construction erected to date.

The Garden City and Its Inhabitants.—These groups, or [illegible] in which [illegible] are gathered [illegible] with the [illegible] the laborers and [illegible], but it was not long before the foremen, [illegible] superintendents made it [illegible] that they [illegible] like a similar [illegible] the [illegible] they had [illegible] the [illegible]. The [illegible] type of dwelling was evolved [illegible] instead of the living room [illegible] a kitchen, dining and sitting room. There was actually a kitchen, dining room, [illegible], the usual bed rooms and a cabinet or toilette or dressing room.

Of these model cities the most important are Tergnier, [illegible] where are found the highest type of dwellings in the devastated [illegible].

The average cost of these houses is about [illegible] at the [illegible] rate of dollar exchange, of which about four-fifths is the actual construction costs, the remainder being for the [illegible] expenses for the installation of water connections, [illegible] lighting, schools, [illegible] gardens and grounds, baths and the usual [illegible] accessories of a well organized community.

To a large extent these cites houses are built of agglomerated slag and cinders (parpaings, as the French call it), this being covered finally with a layer of cement. The foundations are [illegible] a foot and a half thick, the upper walls somewhat less.

Of the more than 50 cités or communities of more than [illegible] (which the French designate as chimneys) which have been brought into being, unquestionably the most important is Tergnier. It is a rail town, a county town, a court-house town as may well be described a French sub-prefecture, with a population of well above 8,000 already, though it only had [illegible] before the war, which left it the most despicable wreck of a town imaginable.

[illegible] all the town is not a before the war inhabitable house still above ground. All is new.

The Northern Railways' Garden City here covers 220 acres on which are actually 1,200 houses at this time and by October these will be increased to 1,427, housing in all over 6,000 employees of this [illegible] railway capital. In all the company proposes to build with its proper resources more than 10,000 houses, distributed all along the line.

Beauty Required, Even in Reconstruction.—No special type exists, save that each shall present certain salient features of accommodation and effect, each with the object in view that these conditions shall be fulfilled with due regard for grace and charm.

A worker's four-roomed house may be rented for 900 francs a year, at normal dollar exchange, say $180.

It is worth mentioning in passing that the outer color wash given to these houses is put on with the well-known American paint sprayer., doubtless common enough in use there, but the first I have seen, an exiled American of more than a quarter of a century residence abroad, in operation here. It is a worthy companion to some Pennsylvania made steel ore cars which I also saw being hauled over the line to a big steel mill in the Meurthe et Moselle.

Perhaps it is true that the Northern Ry. Co. of France first got their garden city idea from America; if so, they have adopted it whole heartedly and adapted it in a marvelous spirit of [illegible]. If there are any other railway [illegible] with more concern for the decent and genial housing of its employees than this it certainly does not exist in Europe. It may curtail stockholders' dividends temporarily, but it will pay in the long run, and it is only long [illegible] that are being made in Europe today.

Government Report on the Port of Boston, Mass. The Board of Engineers for Rivers and Harbors in cooperation with the Bureau of Research of the Shipping Board, has just published a report on the port of Boston, constituting No. 2 of a series of reports covering all the important seaports of the country. The report is [illegible] the most complete study [illegible] of any American port. The purpose in view in the preparation of this report and others of the same series is to present detailed information of particular value to vessel operators, producers, manufacturers, importers, exporters and all other persons having occasion to ship goods through any ports. Copies of the report can be purchased from the Government Printing Office, Washington, D. C., at [illegible].

Expansion and Construction Joints in Concrete Highway Bridges

The following notes are taken from the report of the Committee on Reinforced Concrete Highway Bridges and Culverts, A. B. Cohen, chairman, presented at the last annual meeting of the American Concrete Institute:

Expansion Joints. The distance apart of expansion joints in concrete construction which are necessarily at closer intervals than would be necessary in steel structures of similar magnitude depends upon the type of structure and no specific recommendations relative thereto can be safely given by the committee.

Broadly speaking, there are three types of highway bridge design requiring expansion joints; first, the arch type, with superstructure composed of transverse or longitudinal walls supporting a floor system or with back fill of earth where the sidewalk construction is cantilevered from a parapet wall; second, the T-beam or rectangular slab design, supported on columns or bents; third, the multiple way reinforced flat slab structure on columns. The latter type has not been extensively used, but there is a wide field for its application.

In the development of expansion joint details, the following considerations should be borne in mind. In the arch type, with superstructure, expansion joints in the superstructure must provide for movement in both a vertical and horizontal direction, up and down, for rise and fall of the arch ring and in a horizontal direction due to elemental changes of length in the various members of the floor system.

Where transition for these non-concurrent movements from one section to another is attempted in the superstructure by sliding or vertical surfaces in contact, there is the imminent danger of a shearing failure in these sections in contact, caused by excess of frictional or tortional action over the strength of the section in shear.

Joints placed at the quarter points of the span, approximately at the point of contraflexure in the arch ring, and at the pilasters adjacent to the piers, have proved successful for spans of 90 ft. to 200 ft. This arrangement divides the floor system over each arch in three sections, and eliminates an extremely large moment in the floor system over the haunch of the arch, due to a maximum vertical movement at crown of arch. The amount of moment or tension in the floor system due to vertical movement of the main arch ring varies with the ratio of rise to span; the flat segmental arch causes greater moment than the semi-circular arch of equal span. The principle or effect of the cantilever joint in floor system can be secured in the parapet wall construction of a barrel arch supporting earth fill, by vertical joint through the walls and sidewalk.

For the second type, the T-beam or rectangular slab design supported on columns or bents, the action to be controlled is in the horizontal direction only. In the T-beam type there arises the difficulty of transferring the movement due to temperature changes from the larger through the smaller members as from the deep beams through the slabs. Regardless of the length of structure, the slab should be substantially reinforced in transverse direction to distribute stress or prevent a cumulative strain at change of sections.

The ratio of span length to height of columns or bents should be taken into consideration.

For sliding joints, plates of steel, copper, zinc, or lead, and multiple layers of fabrics or combination of these different plates have been used to reduce friction resistance. Where the bearing covers a wide area there is the danger, if heavy plates are not used, that the sliding medium or plate will conform to a possible uneven surface of a bridge seat and cause a crack. Therefore, great care must be exercised in preparation of the sliding joint or bridge seat, as it is generally called.

The third type, the flat slab construction, can be built in greater lengths between expansion joints than either of the preceding types. Because of the uniform cross section everywhere of both concrete and steel, the slab offers better resistance to temperature changes, the movement being distributed more uniformly throughout its entire length. Expansion joints in this construction are formed by double row of columns, and in good practice the joints should be spaced at distances not exceeding 250 ft.

Construction Joints. The location of construction joints should be shown on the plans, since this detail is a decided help to the contractor in his analysis of the construction problems. The designer should bear in mind the capacity of plant commensurate with the magnitude of the work.

The lengths of reinforcing rods should be predetermined, so that no excessive lengths of rods project beyond the construction joint. The rods should project beyond the bulkhead forming the construction joint far enough to develop bond strength with the next lift of bars. In beam or slab construction, the joint is placed at point of least shear, or maximum moment, and no lap of bars should be made at this joint.

Gravity walls should be built in one operation from footing course to the underside of the coping. Construction joints should be placed at intervals not greater than 30 ft. By addition of temperature steel, sections can be increased to 50 ft. in length. Vertical joints are more desirable than horizontal joints, which tend to become unsightly cracks, due to the resulting efflorescence and gradual disintegration at the joint. Dovetailing adjoining sections and placing copper flashing in the joint are added precaution tending to seal the joint against percolation of drainage water. Construction joints should be avoided along any plain in the structure where water is liable to be concentrated.

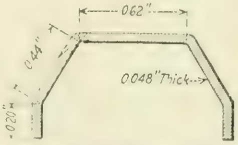
A New Light Aluminum Alloy Having Strength of Soft Steel

Among the most important disclosures in the recently issued report of the Alloys Research Committee of the British Institution of Mechanical Engineers are methods of fabricating a so-called Y-alloy (containing about 4 per cent of copper, 2 per cent of nickel, 1½ per cent magnesium, and the remainder aluminum), which in cast and heat-treated form develops strengths as high as 47,000 lb. per square inch, or when rolled and heat-treated, 54,500 lb. per square inch with elongation of 24 per cent in 2 in. We are indebted to Chemical and Metallurgical Engineering for the following information regarding this new alloy.

It has been very desirable to discover a light alloy which would retain its high heat conductivity and strength up to at least 200 deg. C. to be used for pistons in airplane or other high-duty gas engines. A comparison with an alloy heretofore much used for this purpose is given in Table I, and shows how well the demand was met.

Table II gives a summary of the tensile properties of rolled Y alloy rods and sheets after heat treatment. Table I also contains physical properties at elevated temperatures of a 7/8-in rolled rod, quenched from 480° C. and aged 4 days. From this and a comparison of its strength in the rolled condition given in Table II it appears that prolonged heating to something over 200° C. will remove the hardening effect. On the other hand, test-pieces held 100 hours at 150° C. and tested at that temperature give the same tensile results as though the heating had endured but 30 minutes. Wohler fatigue tests on tubular test pieces at 150° C. (designed to show the expected endurance as connecting rods) gave a safe range of alternating stresses of ± 18,500 lb. per sq. in., wherein the metal may be expected to endure indefinitely, as compared to ± 23,000 lb. per sq. in. at room temperature. Table II also shows that an increased strength and unimpaired ductility may be had by quenching in water from 530° C., about 50° higher than the proper temperature for duralumin. Even higher strengths may be had by cold rolling 1/4-in. plate, reducing thickness 10 per cent in each stage, and separating stages by a qunching from 480° C. Sheet so prepared 0.05 in. thick, after quenching from 530° C. in boiling water, shows an ultimate strength of 58,000 to 61,000 lb. per sq. in., and elongation of 16 to 18 per cent in 2 in.

A channel, shown in the illustration was made in a bending machine from heat-treated rolled strip, and cut into 6-in. lengths with squared ends. This was seated on ball centers, and tested in compression. A buckling stress of 30,600 lb. per square inch was developed by Y alloy, a figure 13 per cent higher than duralumin.



Rolled Channel for Compression Member.

Y alloy is as light as any of the stronger aluminum alloys which have yet been produced, and is distinctly superior to most in the ease of manufacture. Its great superiority lies in a very remarkable resistance to corrosion, and its entire immunity from intercrystalline cracking under prolonged loading (season cracking). The eleventh alloys research report notes that both in the cast and rolled condition the Y alloy possesses considerably better powers of resisting corrosion, even when immersed in sea water, than the other high-strength aluminum alloys.

TABLE I—TESTS OF LIGHT ALLOYS AT HIGH TEMPERATURES.

	—88:12 Cu:Al—			Y alloy, sand cast			Y alloy, heat-treated rod	
Temp., Deg. C.	Ultimate.	Elongation.	Conductivity.	Ultimate.	Elongation.	Conductivity.	Ultimate.	Elongation.
20...	30,000	7.2	....	24,000	1.8	....	54,500	24.0
100...	......	....	..	......	...	.	50,000	21.6
150...	......	....	....	......	...	.	48,000	25.9
200...	14,000	5.0	....	......	...	...	11,000	24.0
250...	9,000	6.0	..	23,000	1.0		......	...
300...	6,300	6.0	0.37	20,000	1.6	[illegible]	......	....
350...	3,400	19.0	....	11,500	6.0		......	....

*Conductivity of gray cast iron at 300 deg. C. is 0.10.

TABLE II—SUMMARY OF TENSILE TESTS ON ROLLED Y ALLOY.

Material	Condition.	Elastic limit.	Yield point.	Ultimate.	Reduction of area.	Elongation in 2 in.
7/8-in. rod	Hot-rolled	......	26,000	39,400	30.0	20.0
	Quenched from 530 deg. C. and aged..........	17,260	31,500	51,000	33.0	23.0
	Cold-rolled from 1¼-in., hot-rolled quenched from 530 deg. C. and aged	17,200	31,000	54,100	31.0	25.0
1/2-in. rod	Cold-rolled from 7/8-in., hot-rolled, quenched from 520 deg. C. and aged	......	33,400	51,200	31.0	27.0
0.05-in. sheet	Hot-rolled, quenched from 480 deg. C., aged	....	36,000	52,000		19.0
	Hot-rolled; quenched from 530 deg. C., aged.	......	38,700	58,200	....	19.0
	Cold-rolled, quenched from 530 deg. C., aged	22,000	46,[illegible]	60,200	....	17.0
0.015-in. sheet	Cold-rolled; quenched from 530 deg. C., aged.	......	47,[illegible]	62,800	....	17.0

An Interesting Project for the Training of More Skilled Workmen

By WARREN H. McBRYDE,

President, Industrial Association of San Francisco.

On Thursday, May 18, the Industrial Association of San Francisco, in co-operation with the Master Plumbers' Association, opened in San Francisco a school for the training of plumbers.

Each applicant for admission to the school has been rated according to his standing in an intelligence test, and placed in one of three groups. Instruction and training of the first group, under the direction of a skilled master plumber, has already begun. At the end of two weeks, members of this group will go out on jobs or into the shops of the master plumbers for four weeks; and group 2 will enter the school. At the end of the second two weeks, members of group 3 will enter the school. At the end of the third two weeks, members of group 3 will go out on jobs or into the shops, and group 1 will return to the school for another two weeks of intensive instruction and training.

This method of two weeks in the school and four weeks on the job or in the shops of master plumbers, will be followed until each group has had a minimum of eight weeks of intensive training in the school. While attending the school (which is in session eight hours a day, five and one-half days a week) students will receive no pay. But while on the job or in the shops of master plumbers they will be paid the regular apprentice wage of $2.50 per day. Through exercising care in the selection of the students and applying the intensive method of training described, it is believed possible to turn out competent journeyman plumbers in from a year to a year and a half—a saving of virtually three years over the old method.

New Systems of House Construction

Steel and Gypsum House.—A residence consisting of a structural steel frame with non-bearing gypsum board walls and partitions on Simplex steel studs was constructed recently at Toronto, Ont., by the Ontario Gypsum Co. The work is described by the Gypsum Co. in The Contract Record, from which the notes following are taken.

Owing to difficulty in securing steel lumber in Canada the company secured standard size I-beams and channels which it utilized to the best advantage in the framing.

The corner posts were 4x4x⅜ L, as were the stair well posts. The intermediate posts were 3x3x5/16 L. The joists were 9-in. steel I joists at 7.7 pounds. The supporting frame was made up of 6-in. and 9-in. channels, and the roof frame was made of 4-in. steel I joists. Metal cross bridging was used in the floor construction.

The floors were constructed of gypsum board laid down on top of the steel; wood sleepers were put on and plaster put in between the sleepers. The finish will be hardwood flooring nailed to the sleepers.

The roof was built up of gypsum board on top of the steel, heavy poultry netting on top of the gypsum board and then hardwall plaster put on in two coats, troweled smooth, and asphalt plate shingles laid on top of this.

All the partitions were constructed of Simplex steel studding, gypsum board and hardwall plaster.

Another innovation in this house was the elimination of lime mortar for finish, Gyproc finishing plaster being used instead.

The following costs were given in The Contract Record:

Applying the gypsum board and the reinforcing wire on the roof cost 64 ct. per yard. There was a considerable amount of labor entailed, and the method was entirely new to the men. Plastering the roof two coats to a thickness of 1¼ in. cost 42 ct. a yard, and plastering the outside walls on top of the gypsum board with one coat of neat pulpstone hard-wall plaster sanded and one coat of Pozzo base pebbled into the first coat of hardwall plaster cost 28 ct. per yard. The applying of the Simplex studs, gypsum board and netting on the outside walls cost $1.10 per yard. Scaffolding on the outside walls 13 ct. per yard. These are all labor costs. Labor costs per yard follow:

Fixing board and fence wire on roof	$0.64
Plastering two coats 1¼ in. thick on roof	.42
Fixing Simplex studs, boards and chicken wire on outside walls	1.10
Plastering outside walls—one coat neat material, one coat Pozzo base	.28
Scaffolding outside walls	.13
Fixing ceiling runners and boards	.27
Fixing partition studs and boards	.13
Plastering interior base coat	.14
Plastering two coats on floor	.45
Fixing board and wire on floor	.22
Strapping floors	.16
Plastering between strappings	.25

It is stated that these costs do not truly represent what could be done on buildings of this character when the mechanics became more used to the work.

Hillman System of Hollow Wall Houses.—Monolithic hollow wall houses are being constructed in Los Angeles by the Hillman System in competition, it is stated, with frame construction. The National Builder, from which the matter following is taken, gives the following details of the system:

Hillman system walls are built with forms consisting of steel plates 24 in. high and of varying lengths. Four plates of equal length constitute a form unit for pouring a hollow wall.

In practice the forms are raised on standards of 1½-in. galvanized pipe, which are set up on the foundation between the walls, to be constructed and removed when the walls are completed.

The form plates are made of 12 gage steel, rolled at the top, reinforced at the bottom with 1¼-in. angle iron, and reinforced at the sides with two vertical, U-channel arms pressed out of 3/16-in. steel. These plates are made in 3, 4 and 6 ft. lengths, 24 in. high. The inside plates are notched to receive metal cross ties, which are set in place before pouring.

An 8-in. wall is built with 2-in. slabs and a 4-in. air space, and a 10-in. wall with 3-in. slabs, and a 4-in. air space. The forms are adjustable for thicker walls. When the standards are set plumb no further adjustment of the equipment is necessary to insure a plumb wall. The lap joints make the wall continuously smooth and obviate leakage through the bottom of the forms. The corners are built with sets of four right angle forms, which are self-aligning. These are hooked at the top and bottom to the wall forms. Extension wall plates to provide for fractional measurements are attached in a like manner.

In constructing partition walls, or foundation and solid exterior walls, both forms are suspended from the same side of the standard. Sometimes, in the case of heavy solid walls, one plate is suspended from each side of the standard, which is left in the concrete. Standards are not required on walls less than 4 ft. high. In two or more story work the thickness of the walls or the thickness of the inner wall is reduced at the floor line. When desired the walls may be filled solid beneath the bearing of the floor joists. Intersecting walls and partition walls are poured one course behind the main walls, and are tied into the main walls by means of steel reinforcing.

Pegs of reinforcing steel 8 in. long tie the walls to the foundation and project from the foundation for the forms to clamp against for the first course. Vertical reinforcing steel is set on 2-in. centers in the first course and is continuous from the foundation to the required height. Horizontal steel is placed in the forms at each course and turned at the corners. Floor joists may either bear on the foundation wall, on studding built out from the wall, or be received through the inner wall. Openings are framed at any point by blocking forms with rough strips lightly built up to any required size. Blocks are set in forms and built in wall for nailing permanent frames and trim. Plumbing and electrical conduits are carried in the air space.

The double exterior walls of a one-story house 28 ft. by 43 ft., and a garage 20 ft. by 20 ft., comprising a wall area of 2,456 sq. ft., are reported as being erected in October, 1921, at a cost of $419. The walls were 8 in., built up of two 2-in. slabs, with a 4-in. opening, and were reinforced with ¼-in. square deformed bars placed vertically and horizontally on 2-ft. centers in both walls, and tied with steel ties built in the walls 1 ft. apart in every 22 in. course. The concrete was mixed in a batch mixer and placed by hand. The wall cost, averaging 17 ct. per square foot surface of double wall, is distributed as follows:

125 sacks cement, at $0.85	$106.25
15 yd. sand, at $2.50	37.50
15 yd. rock, at $2.75	41.25
Steel	49.00
Labor (mixing and placing):	
1 man at $8, 3 men at $4, for 7 days	140.00
Labor (setting up equipment)—4 men, 1 day	20.00
Labor (taking down equipment)—4 men, 6 hours	15.00
Frames for blocking openings	10.00
Total	$419.00

After forms were removed, the interior and exterior walls were ready for the plaster and stucco, which was put on at a less cost than would be possible with metal lath. The article in Concrete is based on information furnished by the Monolithic Hollow Concrete Form Corp., Los Angeles, Calif.

Needham System of Concrete Building Construction.—A system in which slabs of reinforced concrete, cast and seasoned at a central plant are used, has been developed by Needham Brothers, Houston, Tex. The system is described in the National Builder, from which the matter following is taken.

The Needham system of building is composed of slabs of pre-cast reinforced concrete 16 in. wide, which are made in the shape of a channel. These slabs can be made in any length to suit the job, and when erected form dovetail sockets at the upper end, which are locked together when the concrete cap beam or wall plate is poured. The bottom is locked into the foundation. The walls are continuously hollow with air circulating openings through the beam, which communicate with the space between the opposing side slabs, whereby continuous horizontal and vertical circulation of air is obtained. This is designed to assure the elimination of moisture condensation. Therefore the hollow wall concrete house has stood the test of the critics.

The full length of slabs for a bungalow, or one story of a taller building, are sufficiently light in weight that they are readily carried and erected by four laborers. The weight of a slab is about 300 lb. They are delivered to the job in motor trucks and stacked at the building site like lumber.

The erection of the building proceeds as follows: First the foundation is poured as in ordinary building construction. Of course there is a continuous foundation wall or bearing of concrete. The wall is not less than 10 in. wide at the top, the outside of which is flush with the outside of the construction above. If a water table or break at the foundation line is desired, the wall may be made thicker. After the foundation is poured to the under side of floor joists, the joists are placed; those resting on foundation walls have square ends. A strip is then nailed to the top of joists parallel to walls to form the line of inside wall. These first floor joists must not project beyond inside wall line. The carpenters then erect partitions and ceiling or second story joists as an ordinary construction. After the ceiling joists and floor joists are in place the carpenter cuts a short piece of board in between each joist and the depth of the joist just inside the face of the wall. The building is now ready for the erection of the Needham system walls. If there is a second story, the carpenter can be put at work erecting his partitions and if not can erect his non-bearing partitions or such other work as he may have.

The inside slabs of the Needham System are set first. After three or four inside slabs are set the hollow space is slushed with grout and the outside slabs are set. So on until entire wall is built. As soon as the outside slabs are set the carpenter places a wood board outside the wall entirely around it to hold Needham slabs in place and at same time form a mould with the board cut between the joists for the concrete girt, which is run around top of wall. The ends of the joists are notched so that the form extends slightly below the top of the slabs. This concrete girt also fills up the small depressions formed at the top of the slabs, thus locking the entire structure together. The ceilings or second floor joists are anchored to the wall construction by means of the reinforcing rod of the vertical rib which is left projecting from the end of the slab. This is shown in one of the detail sketches. Construction for two-story structure proceeds along similar lines as for one-story structures. For two-story construction the vertical rods of the slab project from the bottom of slabs.

Any type of door and window frame may be used with this wall construction; the recommended window frame is that used in ordinary frame and stucco construction. A small stiff-leg derrick of very light construction has been used to very great advantage on construction of this type house in Houston.

To carry the ceiling joists during the erection of the concrete exterior wall temporary studs are spaced just sufficient to carry the load. These are removed as soon as the joists can be tied into the walls. Since the walls are provided with air space plaster may be applied direct to the interior surface of the slabs or the usual furring used if desired.

The exterior is stuccoed directly on the concrete with any finish or kind of stucco desired.

The following estimate of the cost making and erecting the concrete slabs was given out by Needham Brothers:

Cement, 1 sack at $0.83½	$ .835
Gravel, 4 cu. ft. at $0.14	.560
Sand, 2 cu. ft. at $0.04½	.090
Reinf., 19 lb. at $0.04	.760
Total	$2.245
(The above quantities are sufficient for three slabs, 1′ 4″ x 10′ 0″.)	
Cost per slab	$ .74½
Cost per sq. ft. of slab	.05 6/10
Cost of making slabs:	
One foreman at $8	$ 8.00
Two men at $3	6.00
One man at $3.50	3.50
Total cost one day's operation	$17.50
(Above gang will make 25 slabs per day. Cost per slab, 70 ct.)	
Cost of material per slab	$ .745
Cost of labor per slab	.70
Labor and material per slab	$ 1.445
Cost per sq. ft. of slab	.10 4/5
Cost erection per sq. ft. slab	.01
Cost per sq. ft. of wall, about	.23

The slabs and the system of using them have been patented.

An English Patent System of House Construction.—A system evolved by Col. Kent in 1919 to meet the housing problem in England, by reducing the cost of building and the time of erection, incidentally eliminating most of the skilled labor usually employed on the walls is described in the February Royal Engineers' Journal.

The system is based on the "Pier and Panel" principle, the piers being of reinforced concrete, anchored into the foundations, and the panels consisting of long thin slabs of concrete, or other suitable material which bridge the spaces between the piers.

The piers and slabs are pre-cast; the former have bolts cast horizontally in them, projecting inwards, and to these bolts the slabs, door-frames and window-frames are secured by nuts, by unskilled labor in a very short time.

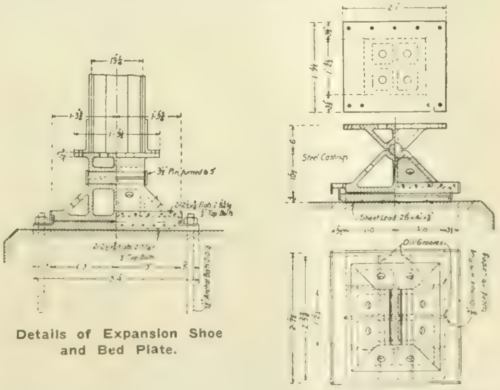
In an ordinary small house the piers are set up at 4 ft. 6 in. intervals, and the bolts are set at 18 in. vertical intervals, the slabs being 18 in. high. In a dwelling house there are two skins of slabs, each 2 in. thick, with an air space of 5 in., which is practically continuous both horizontally and vertically all round the house, for the piers do not block more than 2½ in. of the air-space, leaving 2½ in. clear.

The outer slabs are secured against the shoulders of the piers by means of saddle blocks of hard wood or woodcrete, which are threaded on the bolts and pressed by nuts against the vertical edges of the slabs. The inner slabs are placed against the faces of the saddle blocks (which are 5 in. deep) and are secured there by nuts on the bolts or by the cotter-pins. The nuts will usually be countersunk, the corners of the inner slabs being rebated to 1 in., and the inner face of the wall is then plastered to a flush surface.

Sliding Bearings of Annapolis-Granville Bridge

The recently completed highway bridge over the Annapolis River, connecting Annapolis Royal and Granville, Nova Scotia, presents some interesting features. One of these is the provision for expansion by the use of sliding bearings, for all spans instead of the usual nests of rollers. The bridge consists of ten through riveted steel spans, one of which is a swing span. It provides a clear roadway of 16 ft. with 14 ft. of head room and two 4½ ft. sidewalks. The structure contains about 870 tons of steel. The bridge is made up of six 102-ft. spans, one 157-ft. span and one draw span of the same length, one 109-ft. span and one 294-ft. span. We are indebted to The Contract Record for the following information regarding the sliding bearings, details of which are shown in the accompanying illustration.

The lower casing, which rests on a steel bed-plate on the pier is finished on its upper surface, and scored with oil-grooves. This surface is raised ½ in. above the remainder of the base. On the sides parallel to the center line of the bridge, 5 in. x 3 in. x 7/16 in. angles are riveted to the base, and the upstanding 3-in. legs are planed down to ¾ in. above the bearing surface. These angles take the lateral thrust. Along the other two sides, 2½ in. x ⅜ in. flats are tap-bolted, and all joints are welded or packed so as to complete a shallow oil-tight open box some ¾ in. deep. The bearing surface of the upper casting fits into this box, and 2½ in. x ⅜ in. flats tap-bolted to it around its projecting sides complete a dust-proof cover for the box, with sufficient clearances to permit of the movement due to the expansion of the truss. An oil hole is provided so that the bearing box can be kept full of oil.



Details of Expansion Shoe and Bed Plate.

The bridge was designed by W. Chase Thompson, Consulting Engineer, Montreal, Que. The above type of expansion bearing was used by Mr. Thompson on a highway bridge erected in 1914 at Lennox Passage, Nova Scotia.

Maintenance Methods for Highway Bridges in Minnesota

Some excellent suggestions on highway bridge inspection and maintenance, particularly as it relates to timber structures, were given by E. J. Miller, Assistant Bridge Engineer, Minnesota Highway Department, in a recent issue of The Improvement Bulletin. His article follows practically in full:

In order to get the value out of each bridge in the state when once it is built, it is very essential to have a definite maintenance policy. Our state law requires that each bridge over a 10-ft. span must be inspected once annually. This, in itself, is a very good law and has a twofold purpose. First, prevention of accidents and second, it creates the incentive for getting a dollar's worth of use out of every dollar spent in bridge construction.

Wood bridge floors require very frequent renewals, often having to be replaced in three year periods. Wood floors and stringers are the most liable to deceive the inspector. The stringers may appear to be all right on the sides and yet may be 75 per cent rotted away in the center, leaving but a thin shell outside. This necessitates taking up at least one floor plank in each panel to find the actual condition of the stringers unless other means are used to detect defective timber.

Testing Condition of Bridges with the Ice Pick.—We have used during the past year a common ice pick with very good success in examining wooden structures. This consists of a long slender steel prod tapering to a very sharp point, which can be run down between the floor planks. It is often jabbed half a foot into a defective stringer, if rotting is well advanced. This instrument also can readily be used to prod timbers such as caps or wood piles, in order to ascertain the soundness of the wood itself. It will penetrate defective wood with surprising ease and enables one to make sure conclusions as to soundness, where the eyesight would probably be deceived.

Protecting Tops of Stringers. When renewing the wood floors on wood stringers, the tops of the stringers themselves should always have some protective coating, inasmuch as the stringers deteriorate from the top down. This, no doubt, is due to water penetrating and following the spikes down into the stringers and on account of the tops drying off last. There are several good ways of protecting the tops of stringers, any one of which may be used to good advantage. One may put on a brush coat of creosote, a swab coat of hot pitch, a coat of tar, which may be heated if it is too stiff to run properly, or galvanized iron sheets which may be placed on tops of stringers, although this method has gone into the discard on account of its cost and inconvenience in placing.

Creosote or pitch treatment on the tops of stringers is the least expensive and from investigation up to the present time is at least equal to using galvanized iron. Local conditions very often determine what one can use, as all these materials are not readily obtained in various parts of the state.

Wood Bridge Floors. I do not believe that single plank floors laid crossways are either economical or practical for present day traffic. We have had very good success with laying our sub-floors crossways and our top floor of oak 2 ins. thick laid longitudinally. This oak wearing course on secondary roads need be only 8 ft. to 10 ft. wide, but on well traveled or primary roads should be the full width of the bridge.

When using this, a sub-floor should be laid with ¼-in. to ⅜-in. open joints for drainage. When using an oak top floor the sub-floor should preferably be treated with creosote or hot pitch to prevent its rotting down. The oak wearing course itself may be painted with tar or pitch and sanded, if desired. Such treatment will give the floor the appearance of asphalt and traffic will be perfectly noiseless when crossing it.

Tarvia Concrete Wearing Surface. Another type of bridge floor wearing course is Tarvia K. P. concrete. This is somewhat different from other types and very often makes maintenance [illegible] on account of not having been rolled or tamped thoroughly enough when first placed. When using this type of wearing course the wood floor, if such, should be made as stiff as possible before placing the Tarvia concrete and the wood stringers [illegible] should be made two panels in length, staggered and should be well braced at mid-panel. The sub-floor should preferably be tongued and grooved, and if laid diagonally, using 20-ft. planks on a 16-ft. width roadway, considerable added stiffness is obtained in the floor system.

If the sub-floor is ordinary bridge plank the cracks and openings shall be thoroughly caulked with oakum or lath securely nailed and all knotholes should have tin coverings tacked on before placing wearing surface. If the bridge floor to be covered with tar concrete is within 100 miles of the Twin Cities and requires at least 1,000 gals. of tar, it is the most expedient and economical method to truck the hot tar to the job in a 1,000-gal. distributor. The reason for this is that tar can be trucked a distance of approximately 100 miles and delivered hot to the job at the same cost that it can be shipped in barrels and heated in kettles.

Only crushed stones should be used in laying all tar concrete wearing course, as gravel pebbles have the disadvantage of starting to roll under direct wheel loads. Seal coats on tar floor should preferably be placed a month or two after the floor is completed as this enables inequalities to be evened up and possible ruts to be removed which have occurred under heavy travel.

Creosote Block Floors.—Creosote block floors may be laid on plank or concrete sub-floor. If laid on plank the sub-floor should be tongued and grooved. Such floors are very satisfactory and have a length of life of from 10 to 15 years. It has been a matter of observation that creosote block floors have a longer length of life on a bridge than on an adjacent pavement. This is possibly due to resiliency in the bridge reducing the effect of the impact. Asphaltic concrete floors are only suitable on concrete floors and should be laid in connection with the paving project.

Six Points to Be Remembered When Making Bridge Inspections. Bridge inspections can be made according to no set rules. The principal object of the inspection should be to look after things that are wrong. The following general outline should be followed.

First: The condition of the floor plank and stringers.

Second: The condition of the steel with regard to rust and paint.

Third: The condition of the expansion devices.

Fourth: The condition of the railing and bridge rails, taking due regard for broken units and condition of paint.

Fifth: General strength of the entire structure. The maximum safe load which the structure will carry should be determined by this inspection.

Sixth: Recommendations for repairs and method of carrying out such repairs.

Painting Steel Bridges.—It has been found that nine out of ten steel bridges require painting, since practically all bridges are forgotten once they are built. The average steel truss will have a length of life of only 20 years if no attention is paid to painting. Therefore, this phase of bridge maintenance should be very diligently taken care of. Bridges should be thoroughly cleaned of all dirt, scale, rust and old paint before any attempt is made to repaint them. A structure very badly rusted should receive a first coat of red lead and oil and then a second coat of a carbon or a graphic paint of the best quality obtainable. The old adage that "The best is the cheapest" applies with especial emphasis to bridge painting.

A structure which is rusted only in spots and in local pockets should be thoroughly cleaned and scraped and such bad places touched up with red lead and oil before painting with the top coat.

Steel structures should normally be painted as soon as the protection surface begins to show signs of breaking down and rusting is about to take place. It is of especial importance that all pockets, corners and grooves shall be thoroughly cleaned and painted and that they are not overlooked. "A chain is no stronger than its weakest link," and if such grooves and pockets are overlooked for several years one may find that the steel is entirely rusted through and the collapse of the structure is imminent.

The maintenance department has adopted olive green as a standard color for bridge painting and also has adopted the practice of dating all bridges by means of a stencil showing the time of the last painting. This practice of dating bridges when painting them has been customary with the railway maintenance of way departments for a number of years.

Deductions Arrived At from Use of Pneumatic Paint Machines. The Minnesota State Highway Department has operated a pneumatic paint machine during the latter part of the last season and the following reductions were made when comparing with hand painting.

First. The air brush painting has proved the most economical.

Second: Painting with air brushes proves the most thorough on account of the ease of getting into some inaccessible places. It was found, however, that it was very essential to have skilled operators on account of the difficulty of knowing just when the paint coat was applied to the proper thickness.

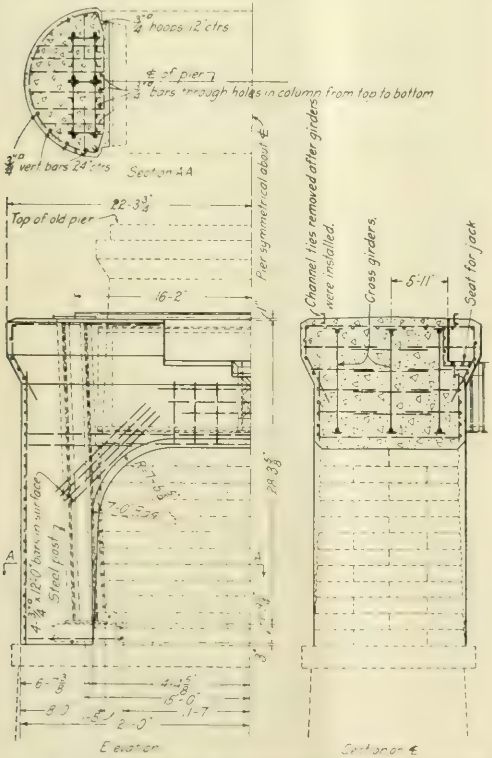
Bridge railings and approach rails to the bridges are being painted white on the trunk highway system for the obvious reason of reducing the possibilities of accidents and making night driving less hazardous.

During the last season the total length of 2,000 ft. of bridges have been painted and the average cost per lineal foot for all conditions was $1.12. This cost did not include interest and depreciation on equipment used.

Double Track Spans Placed on Single Track Piers

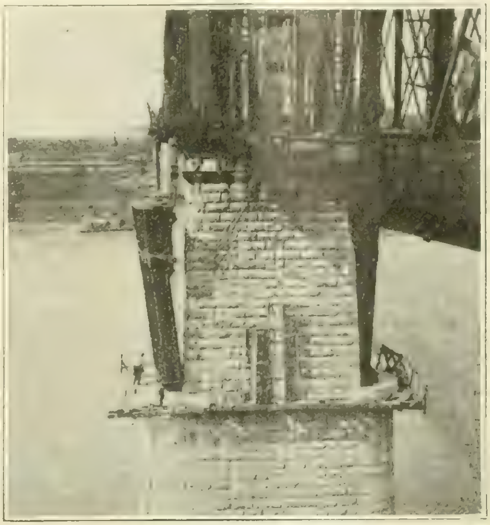
A notable feature of the renewal of the Cincinnati Southern Ry. bridge over the Ohio River, now nearing completion, is the utilization of the original piers, built in 1876 for single track spans, to carry a new superstructure several times as heavy and designed for double track.

The old bridge consisted of four river spans. Two of these were simple fixed spans of 300 ft., the third was a fixed channel span of 519 ft. and the fourth was a symmetrical swing span of 370 ft. center to center of rest piers, this swing span being intended for use at times of high water when there would be insufficient clearance under the 519 ft. span. All of the spans were of wrought-iron, Whipple trusses on limestone piers carried to rock (blue limestone) foundation by the open copper dam process. The new spans average 8,200 lb. per lineal foot of bridge, while the old 519-ft. span averaged 4,500 lb. per foot of bridge. The design loading for the new span is Cooper's E[illegible] the old spans were designed for a live load of 1,800 lb. per lineal foot of bridge.



How the Tops of the Piers Were Strengthened and Enlarged to Receive th New Spans.

To support trusses spaced 3[illegible] ft. [illegible] in. center to center on piers having a top length of only about 28 ft. over the coping was by no means the least of the problems imposed in the renewal of the bridge. Fortunately, the overall length of the piers at the top of the starling, [illegible] ft. below the coping, was about 42 ft., thereby offering a solution in the reconstruction of the pier above that point. The great concentrations to be imposed by the new span, together with the need of supporting the existing span during erection of the new work, called for the use of structural steel bents as a means of applying the new load to the piers. The starling coping was removed and enough of the pier ends cut away to make room for heavy steel columns and grillage footings to take the end bearings of the new trusses. To apply the load as far from the end of the pier as possible, these columns were inclined inward so that the bases are 14 in. closer to the center line of the bridge than the tops of the columns, the resultant outward thrust at the top being resisted by tie members extending across the faces of the piers and connecting the tops of each pair of columns. However, application of the superstructure load is to be further distributed (following the removal of the old spans) by taking down enough of the pier top between the columns to permit the introduction of three cross girders. These will serve as diaphragms connecting the two columns of each pair and will be wedged up on the masonry so that a considerable portion of the column load will be distributed to the center portion of the pier.



Erecting One of the Steel Columns Used to Strengthen the Piers.

The top of the piers will be jacketed with concrete to enclose the structural steel and provide a bridge seat and coping.

At Pier 3 an additional complication is introduced in providing a seat for the lifting equipment required for the movable span. This necessitated a pair of cantilever girders projecting from the side of the pier. Pier 1 at the south end of the lift span is on pile foundation and has been completely encased in a heavy concrete jacket, also on pile foundation.

The work is described in Railway Age, from which the above note and illustrations are taken.

San Francisco Industrial Association Starts Trade School.—The Industrial Association of San Francisco, which has charge of the labor relations of the section of the building industry operating under the open shop, has started a trades school which will eventually provide courses in most of the skilled building crafts.

The American Construction Council

The purposes of this latest development in the construction industry were outlined by Arthur S. Bent, president of the Associated General Contractors of America, in an address May [illegible] before the Chamber of Commerce of the United States, from which the notes following are taken.

To Unite All Elements.—For the first time in the history of American industrial development a great industry will attempt through an organization known as the American Construction Council to unite all of its elements, including architects, engineers, general contractors, representatives of construction labor, manufacturers, material dealers, representatives of government bureaus, and public utility departments in an effort to raise the standard and efficiency of the construction industry and to improve the service which that industry renders the public. The nearest precedent for such an effort is that furnished by the motion picture industry in its attempt to co-ordinate all of its principal factors and produce under able leadership the best of which that industry is capable.

The American Construction Council will bring together the many component parts which make up the industry and will carefully analyze their common problems looking toward a better understanding of them and toward a satisfactory solution of these problems.

Until recently each branch in this great industry has looked after its own interests, unconscious of its co-operative responsibility to the other elements and very often indifferent to the welfare of the public. Since the late war the lack of co-ordination of mutual understanding and of consideration for the public has been more evident than in previous years. It was necessary to postpone all but essential construction during the war, leaving at the close of 1918 an enormous deferred volume of construction work. In 1920 we began to catch up only to fall back again in 1921; today we have a deferred program in construction amounting to over $15,000,000,000. Of the housing shortage the general public is well aware. A similar shortage exists in every branch of construction. We have not enough office buildings, or schools, terminals, railroads or highways, while water supply systems, hydro-electric power stations and reclamation projects are far behind present needs. The 250 national associations in the industry have discovered much duplication of effort and also their inability to grapple effectively with the problems that extend beyond their own special fields. Each is ready and anxious to submit its common problems to an all-embracing organization which will strive for an elimination of duplication and waste and for more effective work. These organizations appreciate that the public has a right to demand immediate action through such an effective movement as just described—a movement dedicated to the improvement of the service which construction renders the community, states and nation.

The tremendous possibilities of such an organization naturally appealed to Secretary Hoover's passion for efficiency and standardization and have induced him to consent to presiding at the formal organization meeting and Mr. Franklin D. Roosevelt to accept the presidency of the organization.

What the First Efforts of the Council Will Be.—The first efforts of the council will be devoted to a solution of the more pressing of the many problems which await settlement. Among the most important of these are:

The formation of a code of ethics acceptable to the industry and to the public;

The gathering of adequate statistics so that the industry may operate intelligently. While there are partial statistics collected by many sources, they have not been brought together and interpreted in the light of all the facts;

A reduction of the national shortage of building mechanics and the establishment of the necessary apprenticeship systems;

A national study of building codes and the working out of a program for carrying recommendations into effect;

A revision of the existing freight rates on construction materials;

A stabilization of the construction industry to mitigate the evils of seasonal employment and the trade migration of labor;

The encouragement of local building shows and the adoption of a publicity program capable of giving the public an adequate conception of the magnitude and work of the construction industry.

In a recent letter to H. M. Daugherty, Attorney General of the United States, Secretary Hoover made the following comment on the importance of the second of the above mentioned items—the need of statistics:

Commercial progress in industry has always been measured by the advance in knowledge of those engaged in industry. It is impossible for men to acquire or secure all possible knowledge at one time. Its acquisition is a growth resulting from continuous, intelligent inquiry. The knowledge of an industry that is necessary and essential to its success must embrace all facts and circumstances that will in any way influence that industry.

The Council will not aim to set up another association, but rather to be a council of existing associations for the development of the best standards in the industry.

Organization of the Council.—In its organization the Council will be made up of the following groups, each with equal voting power: Architects, engineers, construction labor, general contractors, sub-contractors, material and equipment manufacturers, material and equipment dealers; bond, insurance and real estate interests, construction departments of public utilities, and the construction departments of federal, state and municipal governments.

The value of this form of super-organization has already been proved by the success of the National Board for Jurisdictional Awards and the Joint Conferences on Estimating and Standard Construction Contracts. The American Construction Council will be the result of a natural economic demand for an effective, fully representative medium necessary for the growth and prosperity of a great industry. It is a logical step in the evolution of our industrial system and it is significant that construction, the key industry of the country, is the leader in this movement.

A few of the 250 national associations which have been invited to become represented in some one of the ten groups of the American Construction Council:

American Institute of Architects,
Federated American Engineering Societies,
American Association of State Highway Officials,
Associated General Contractors of America,
Building Trades Division, American Federation of Labor,
National Building Trades Employees' Association,
National Federation of Construction Industries,
National Building Congress,
National Association of Supply Dealers,
Associated Tile Manufacturers,
National Builders' Supply Association,
National Association of Builders' Exchanges,
Contracting Plasterers' International Association,
National Association of Real Estate Boards,
Heating and Piping Contractors' National Association,
Common Brick Manufacturers' Association,
National Association of Sheet Metal Contractors,
American Railway Engineering Association,
Bureau of Public Roads,
Insurance and Bonding Companies,
National Banks and Trust Companies,
American Bankers' Association.

That, gentlemen, is the great idea and its tentative set up.

It is felt that the American Construction Council through the strong support of these great national organizations, will make a very important contribution to the industrial prosperity of the nation.

The keynote of this convention has been the vital need to recognize that the business era of individualism has definitely passed, and that our success, indeed our very existence, can be insured only by co-ordination and co-operation. The success of the American Construction Council will, it is hoped, point the way for every other American industry.

Weight of Roof Covering Materials.—The following weights of roof coverings have been published in connection with a campaign for fire prevention, and are accompanied by the statement that nearly one-eighth of all fire damage in this country results from fires communicated through roofs. The weights are all per 100 square feet of roof surface. Prepared roofing in rolls 35 to 100 lbs., wooden shingles about 200 lbs., fire resistant asphalt shingles about 220 lbs., slate 650 to 800 lbs., tile 950 to 1,200 lbs.

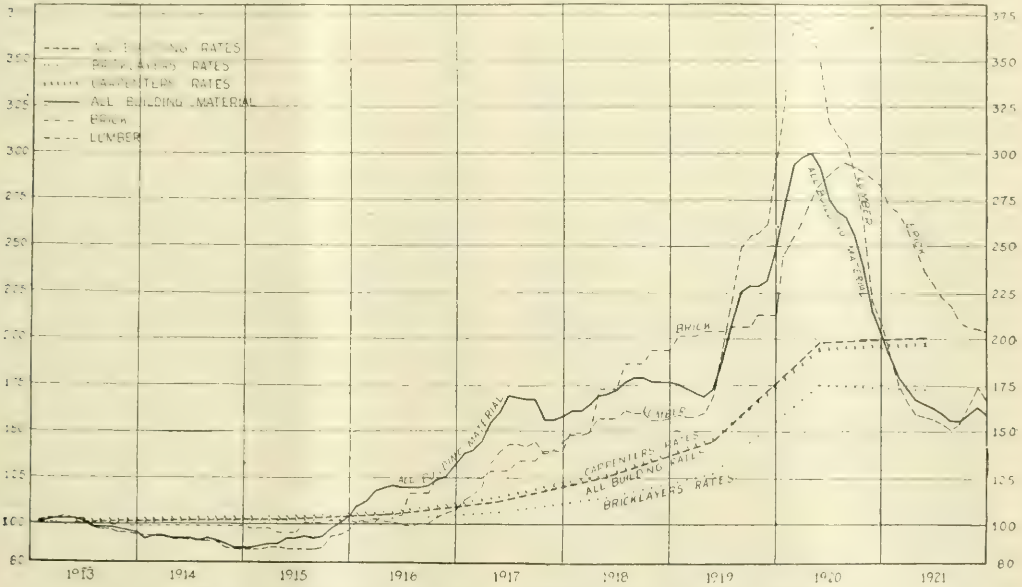
Trend of Prices of Building Material and of Building Wage Rates Since 1913

That the years during and since the World War have witnessed radical changes in the wage rates of the building trades, and not only radical but spectacular changes in the prices of building material, is forcefully brought out in an article in the May Monthly Labor Review, published by the U. S. Department of Labor through the Bureau of Labor Statistics. To show relatively the changes that have taken place since 1913, the accompanying chart and table of index numbers are drawn from the Review.

Wholesale prices are available month by month, but union wage rates are available only as of May 15 each year, consequently their change from month to month cannot be shown. However, the building trade wage rates have experienced no such wide fluctuation as have building material prices. So far as the large cities are concerned, the union wage rate is the prevailing rate, if not the only rate, for the city.

Beginning with 1917 building material prices constantly advanced above building wage rates until 1920, in the spring of which year building material as a whole had reached triple the prices of 1913 and wage rates as a whole had nearly doubled the level of 1913. Beginning with the spring of 1920 and continuing through into 1921 there was a heavy fall in building material prices. Building wage rates, however, more than held their position between 1920 and 1921. The change in the carpenters' wage rate practically coincides with that of all building wage rates combined.

In the table one column shows the change in building material prices as a collective group and another shows the change in building wage rates as a whole. Other columns relate to two of the principal materials used in home building and two of the principal trades. The Review does not give figures for each of the other items of building material or the other building trades. The section of the table applying to prices is abridged to give only the lowest, highest, and average index numbers for each year.



Trend of Building Trade Wage Rates and Wholesale Prices of Building Material.

INDEX NUMBERS OF THE LOWEST, HIGHEST AND AVERAGE WHOLESALE PRICES OF BUILDING MATERIALS IN EACH YEAR, AND OF UNION WAGE RATES PER HOUR IN MAY, 1913, TO 1921.

Building Material, Average, 1913 = 100. Union Wage Rates, May, 1913 = 100.

Year.	All building materials.	Lumber.	Brick, common.	All building trades combined (May).	Bricklayers (May).	Carpenters (May).
1913—Lowest ...	96	95	99			
Highest ..	103	104	101			
Average ..	100	100	100	100	100	100
1914—Lowest ...	88	87	99			
Highest ..	94	94	99			
Average ..	92	92	99	102	102	102
1915—Lowest ...	88	87	96			
Highest ..	104	97	102			
Average ..	94	89	99	103	103	103
1916—Lowest ...	110	99	101			
Highest ...	132	108	125			
Average ..	120	102	108	106	104	106
1917—Lowest ...	138	113	125			
Highest ...	169	144	139			
Average ..	157	135	132	113	107	115
1918—Lowest ...	161	148	149			
Highest ...	179	161	194			
Average ..	172	155	176	126	115	126
1919—Lowest ...	169	158	202			
Highest ...	248	292	213			
Average ..	201	210	206	145	128	146
1920—Lowest ...	204	209	245			
Highest ...	300	373	295			
Average ..	264	307	279	198	175	195
1921—Lowest ...	156	151	204			
Highest ...	192	194	272			
Average ..	165	163	232	201	173	198
1922—January ..	157	166	204			
February .	156	165	202			
March	155	164	200			

In presenting these figures it is stated that a revision back to 1913 has been made in the index number of wholesale prices of building material previously published. Prices of lumber have been obtained in more representative markets. In addition, structural steel, nails, pipe and a number of other articles are now included under building material.

American Machines and Structures in Foreign Fields

Equipment for the electrifications of the Chilean State Railways under a contract for an initial installation amounting to about $7,000,000, was shipped by the Westinghouse Electric & Manufacturing Co. early in June. Among the items of the shipment are three 8,125 kva generators for the water power plant on the Rio Colorado. There will be a 37-mile transmission line of 110,000 volts.

The Siam State Railways have transmitted to the United States Department of Commerce through the U. S. Counsel at Bangkok a form of tender and specifications for the supply of superstructures for steel railway bridges totaling 35 spans and 1,485 meters in length. Tenders must be in the office of the Siam State Railways in Bangkok not later than Oct. 1, 1922. Copies of the papers submitted for the use of American bidders may be obtained from C. P. Sandberg, 143 Liberty St., New York City.

Proper Finishing and Protection Against Rapid Drying, Important Features of Concrete Floor Construction*

By J. E. FREEMAN

The design of a concrete floor and the construction of the floor proper are generally the features which are given consideration by the architect or engineer. Until recently little thought had been given to the actual finishing of the floor surface or to the influence of protection while hardening upon the future service which may be expected from the floor. Many specifications have contained no more than a perfunctory general sentence on these matters.

Recent investigations and reports, however, have shown the importance of proper finishing and protection against rapid drying during early hardening, so it is right to expect that more attention will be given this part of the work in future.

This subject is of direct interest to the owner as well as to the architect or engineer. One man may have excellent concrete floors in his plant, yet fail to realize the essential factors which contributed to their success. Another owner in the same city may find that a floor laid in his building gives trouble from dusting and he assumes that there is some inherent weakness in the construction. Yet he walks every day over firm, durable sidewalks or travels miles over concrete roads subjected to much traffic and showing little or no signs of wear under severe usage.

In comparing floors with sidewalks or roads this fact should be considered: A sidewalk or road is continually being wetted on the surface by rain or melting snow, while a floor within a building remains dry once the initial moisture within the concrete has gone. Consider also that experience has shown the strength, resistance to wear of concrete roads and streets under heavy traffic to be due in large measure to the retention of moisture in the concrete while hardening during the first two weeks after construction, either by pounding or by an earth blanket kept wet. Ponding means dividing the surface area into short sections by dykes and covering it with water to the depth of several inches. Practically all state highway departments require some such method of protecting the concrete road surface during early hardening, usually for two or three weeks so as to prevent a too early evaporation of moisture from the surface by rapid drying.

Few Concrete Floors Properly Protected During Hardening. Very few concrete floors are given any such protection during this period. They may be occasionally sprinkled during the first two or three days after they are finished, but after that are left to dry out and if the weather is hot they dry out very rapidly. Yet what are floors in industrial plants but indoor pavements subjected often to heavy traffic and deserving, therefore, of the same careful treatment which concrete pavements receive?

Lack of adequate protection while hardening has even been responsible for "dusting" of less traveled surfaces such as porch floors. It is strange that the need for keeping moisture in the concrete while hardening has not been more fully realized since the hardening of concrete is not a drying out but a chemical and physical change brought about by combination of mixing water with cement and this change cannot be properly developed if the mixing water is removed by evaporation before the proper time.

This is the reason why basement floors often seem to be better than others: their position below ground prevents as rapid an evaporation of moisture in the concrete as occurs with unprotected surfaces above ground. Yet even here if such floors are constructed during warm weather, some protection during early hardening is necessary to produce the best results.

Proper Protection Increases Resistance to Wear.—Proper protection of concrete surfaces during the early hardening period produces a remarkable increase in the strength of the concrete and decreases the amount of wear, or in other words increases the resistance to wear. The standard specifications for concrete floors adopted by the American Concrete Institute and embodying what is considered to be the best practice in floor construction, require that the surface of a concrete floor be covered with damp sand, etc., for a period of at least ten days after finishing. This practice will produce an increase of over 75 per cent in compressive strength and a similar increase in resistance to wear.

Tests made on 1:2 cement mortar such as ordinarily specified for floor surfaces and covering a 90-day test period show that 10-day protection to keep the water in the original mixture from evaporating will produce a 50 per cent increase in compressive strength and at least a corresponding increase in resistance to wear.

Protection for 20 days gives still greater increases and in concrete road construction where great strength and resistance to abrasion are desired such protection is generally specified.

Clearly this feature of protection during early hardening is decidedly worthwhile. For a slight additional care in construction the returns measured in service rendered by the floor are increased by over 50 per cent for practically the same investment in materials and labor involved in the construction of the floor. The economy is evident, for it is the service given and not the first cost that deserves the greater consideration.

Economy of Good Floor Finish.—The 1921 Report of the Committee on Cement Floor Finish of the American Concrete Institute contains the following paragraph with reference to this subject:

"It may be urged that conditions as to money and time available for ordinary commercial structures as usually built do not allow the carrying out of the provisions given below for insuring proper floors, but all interested should lose no opportunity of urging upon architects, engineers and owners the ultimate financial gain possible for the owner if the necessary precautions are taken with the original installation. For instance, a surface constructed according to the best recommended practice given herein, namely, ¾ to 1 in., wearing course applied some time after the supporting slab is poured, can probably be produced under 1920 conditions for 15 cts. per square foot, while the poorest surface described would cost at least 5 cts. per square foot. Under ordinarily severe traffic, the latter surface will no doubt at once call for the application of a liquid hardener, paint or other remedy at a cost of from 3 to 5 cts. per square foot and in the course of one to five years, for the renewal of the surface at a cost of 20 to 25 cts. per square foot, thus making the final cost of the poor finish much greater. If properly managed practically no time need be lost, but even though the recommended method means a postponement of the use of the building for a period of two weeks to one month, which should be ample time for proper application and curing, assuming that the rental value of the space is 50 cts. per square foot per annum, this means an additional expense of about 2 to 4 cts. per square foot, while the increase in wearing qualities may range up to 50 per cent, to say nothing of the loss and inconvenience arising from the interruption of operations to treat and replace defective surfaces."

Wet Mixtures Not Needed.—The arguments advanced for the protection of floor surfaces during early hardening to insure retention of moisture in the concrete mixture do not however point to a need for wet mixtures. On the contrary, investigations have shown the great detrimental effect which an excess of water in mixing concrete or mortar will have upon its strength and resistance to wear.

It has been found that one definite quantity of water combined with a given mixture of cement and aggregates will produce the maximum strength possible for that mixture, and that increasing or decreasing this quantity is accompanied by a rapid reduction in the strength of the concrete.

For example, if the amount of water used is 20 per cent more than required for maximum strength, the strength of the resulting concrete will be reduced by about 30 per cent; should slightly over 30 per cent excess of water be used, only about one-half the possible strength of the concrete will be obtained.

While too little water also has the effect of reducing strength, the tendency in construction has been to use an excess of water, producing a sloppy or soupy mixture, particularly for floor topping. This amounts practically to wasting cement, for the use of 1 pint more water than necessary in a 1-sack batch to make a plastic concrete, produces the same reduction in strength as if 2 or [illegible] lbs. of cement had been left out of the mix. While in most types of construction the quantity of water required for maximum strength would not make a concrete sufficiently workable, strength must be sacrificed as little as possible and the safest rule to follow is the use of the smallest quantity of mixing water that will produce a workable, plastic mixture.

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*[illegible]

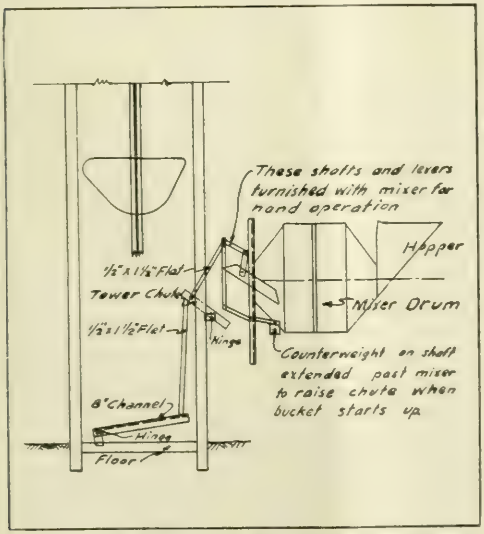
The mortar for floor surfaces should be mixed and placed in a stiff plastic condition such that it must be handled from the barrows with shovels. Methods of proportioning, mixing, placing and finishing that will enable the builder to keep the water content within the lowest practicable limits are of the utmost importance because of the increased strength and resistance to abrasion thus obtained. The gist of the matter might be summed up in the following rule as applied to floors or to any other concrete work: Put the excess water on the concrete during early hardening, not in the concrete when mixed.

Architects and engineers should find out whether contractors' bids on floor construction include provision for proper protection during early hardening, etc., when they realize the greater returns thereby secured on the owners' money investment. Contractors should realize also the benefits of establishing a reputation for first-class floor construction by careful, conscientious workmanship.

Discharge and Tower Chutes Operated by Elevator Bucket

A device for operating the discharge chute of the concrete mixer by means of the elevator bucket is shown in the accompanying sketch, reproduced from Successful Methods:

As the bucket descends it comes in contact with a channel iron hinged at the bottom of the tower. A 1½ in. by ½ in. steel flat connects this channel iron to the tower chute by which the tower chute is tilted. Another flat used in connection with the shafts and levers which are furnished with the mixer for hand operation pulls down the discharge chute of the mixer. When the bucket is raised, a counterweight raises the chutes to allow the elevator bucket to pass. Should the batch not be ready when the bucket is descending, the hoisting engineer merely holds the bucket until the batch is ready. The Terry & Tench Co., general contractors, New York City, have used this arrangement successfully on several jobs.


These shafts and levers furnished with mixer for hand operation
Hopper
½"x1½" Flat
Tower Chute
Mixer Drum
½"x1½" Flat
Hinge
Counterweight on shaft extended past mixer to raise chute when bucket starts up
8" Channel
Hinge
Floor

Arrangement for Operating Chutes by Elevator Bucket.

This device saves the time of the man who ordinarily controls the discharge chute. The elevator bucket is raised and lowered in a vertical line without its course being diverted at the bottom of the tower back toward the mixer.

Preliminary Estimate Figures for Factory Buildings

Figures intended to serve as a basis for the rapid preparation of a preliminary estimate of the cost of a factory, of either the standard mill construction type or the usual type of reinforced concrete construction, are given by Charles F. Dingman of Palmer, Mass., in the April issue of Concrete. We quote as follows from Mr. Dingman's article:

It is not intended that this method will be used as a substitute for the detailed quantity survey method of estimating, though it may be used as a check on the results obtained in that way, but this method is much more accurate than the usual method of using the unit cost per square foot of one building to estimate the cost of a building of similar construction, but of different dimensions.

When it is remembered that the relative amounts of floor and wall costs change with every change in the shape of the building, it will be appreciated that a square foot price which might apply for a small square building might not apply at all for a larger oblong building.

This method of preliminary estimating was not originated by me; all I claim for the present figures is that they have been computed on the basis of current prices and verified by comparison with prices for buildings actually placed under contract. I usually find that a preliminary figure made this way will come between the high and low figures submitted as final bids. It is, therefore, safe for use for the purpose for which it was intended.

PRELIMINARY ESTIMATE FIGURES
(Revised to Nov. [illegible])
Compiled by Chas. F. Dingman, M. Am. Soc. C. E., and verified by comparison with costs of buildings actually placed under contract

MILL CONSTRUCTION—WALLS AND FOUNDATIONS—PER LINEAR FOOT

	Outside.	Inside.
One-story	$ 18.50	$ 18.10
Two-story	32.10	28.60
Three-story	51.70	38.10
Four-story	75.10	62.75
Five-story	98.36	83.50
Six-story	123.10	106.00

Tar-rok, hm and maple floor	$0.55 per sq. ft.
Floor construction	.58 per sq. ft.
Lining floor, extra	.06 per sq. ft.
Roof construction	.74 per sq. ft.
Saw tooth roofs, wood sash	[illegible] per sq. ft. additional
Saw tooth roofs, G. I. sash	[illegible] per sq. ft. additional
Stairs	[illegible] per ft. rise
Plumbing	$200.00 for first 2,500 sq. ft. 100.00 for each added 2,500 sq. ft.

REINFORCED CONCRETE BUILDINGS—OUTSIDE WALLS, INCLUDING FOUNDATIONS, COLUMNS, ETC

One story high	$ 16.40 per lin. ft.
Two stories high	33.40 per lin. ft.
Three stories high	53.20 per lin. ft.
Four stories high	74.25 per lin. ft.
Five stories high	98.50 per lin. ft.
Six stories high	126.00 per lin. ft.

INTERIOR COLUMNS

One story high	$ 80.00 each
Two stories high	141.00 each
Three stories high	190.00 each
Four stories high	274.00 each
Five stories high	[illegible] each
Six stories high	450.00 each
Stairs	[illegible] per ft. of rise

FLOOR AND ROOF CONSTRUCTION.

First floor, cement on earth	$0.23 per sq. ft.
Reinforced floors, inc. topping, 150 lbs. L. L.	.97 per sq. ft.
Reinforced floors, inc. topping, 200 lbs. L. L.	1.09 per sq. ft.
Reinforced floors, inc. topping, 250 lbs. L. L.	1.25 per sq. ft.
Reinforced floors, inc. topping, 300 lbs. L. L.	1.37 per sq. ft.
Reinforced floors, inc. topping, 350 lbs. L. L.	1.46 per sq. ft.
R. C. roof const., inc. covering	.73 per sq. ft.
Single wood floor, add	.22 per sq. ft.
Double wood floor, add	.29 per sq. ft.
Hardener, add	.06 per sq. ft.

INTERIOR PARTITIONS

	Per linear foot 1 story high.
4-in. gypsum	$3.24
6-in. gypsum	[illegible]
4-in. hollow tile	[illegible]
6-in. hollow tile	[illegible]
8-in. hollow tile	3.60
10-in. hollow tile	4.68
12-in. hollow tile	6.36
8-in. brick	5.40
12-in. brick	[illegible]

The figures given in this article are based upon the following unit prices:

Bricklayers' time	[illegible] per hour
Carpenters' time	[illegible] per hour
Laborers' time	[illegible] per hour
Portland cement	[illegible] per bbl. delivered
Brick	[illegible] per M. delivered
Sand	[illegible] per cu. yd. delivered
Gravel or stone	[illegible] per cu. yd. delivered
Timber	[illegible] per M. ft. b. m. deliv.
Plank	[illegible] per M. ft. b. m. deliv.
Flooring	[illegible] per M. ft. b. m. del.

Variations of these costs will affect the figures in the tables as follows:

MILL CONSTRUCTION, [illegible] FLOORS

	Percent.
[illegible] per hour in carp[illegible]	0.91
[illegible] $1 per M on timber	0.31
[illegible] $1 per M on plank	0.78
[illegible] $1 per M on floor[illegible]	0.21

MILL CONSTRUCTION, WALLS

	Percent.
[illegible] 5 ct. per hour in b[illegible]	0.16
[illegible] ct. per hour in lab[illegible]	0.65
[illegible] ct. per bbl. on cement	0.20
[illegible] $1 per M on brick	1.14

REINFORCED CONCRETE CONSTRUCTION

	Percent
[illegible] per hour in [illegible]	0.13
[illegible] per hour in [illegible]	1.25
[illegible] per bbl. on [illegible]	0.46
[illegible] per yd. on [illegible]	0.13
[illegible] per yd. on [illegible]	0.22

Organization and Program of American Construction Council

Franklin D. Roosevelt, formerly Assistant Secretary of the Navy, was formally elected President of the American Construction Council today, at the end of a two days' session held June 19 and 20 in Washington, at which leaders of the construction industry gathered to organize a body representative of all construction elements. John B. Larner, Vice-President of the American Bankers' Association, and President of the Washington Loan & Trust Co., was elected Treasurer.

During the two days' session, 200 architects, engineers, general contractors, sub-contractors, construction labor, material and equipment manufacturers and dealers, financial, bond, insurance and real estate interests, public utility construction departments, Federal, State, county and municipal associations met to consider what could be done to put the construction industry as a whole on a higher plane and to determine ways and means of working together to that end.

The immediate program of action suggested for the new council as a result of these deliberations include:

The formation of a code of ethics acceptable to the whole industry and to the public;

The gathering of adequate statistics from all sources and resulting interpretation having all the facts;

The reduction of the national shortage of building trades mechanics and the establishment of the necessary apprenticeship system;

Co-operation in establishing uniform building codes throughout the country;

Co-operation with the railroads in expediting the revision of existing freight rates on construction materials. The establishing and strengthening of local organizations throughout the country to bring about the co-operation of all elements in conformity with the principles of the council;

The mitigation of the evils of seasonal employment and trade migration of labor;

The encouragement of local building shows;

Simplification, standardization and elimination of waste;

Education of the public to the distribution of its construction and maintenance requirements more evenly throughout the year;

The promotion of health and safety of workmen;

The reduction of loss of life and waste of construction materials from preventable fires;

The study of old buildings in order to establish superior methods of construction;

The education of the public as to the necessity and economy of properly maintaining existing structures.

The executive board of the council elected at this first annual meeting is as follows:

Architects: W. Stanley Parker, New York City; D. K. Boyd, Philadelphia; Abram Garfield, Cleveland; Robert D. Kohn, New York; L. P. Wheat, Washington, D. C.

Engineers: Charles T. Main, Boston; Bion J. Arnold, Chicago; Peter Junkersfeld, New York; Charles F. Loweth, Chicago.

General Contractors: W. O. Winston, Minneapolis; F. L. Cranford, Brooklyn, N. Y.; [illegible], New York; H. H. Wilson, Munhall, Pa.

Sub-Contractors: A. E. Coleman, Chicago; J. R. Alpine, New York; Benj. D[illegible], Bedford; Oscar Remm, Chicago.

Labor: John Donlin, Washington, D. C.; John Coefield, Chicago; John J. Hynes, Chicago; Wm. J. McSorley, Cleveland.

Material and Equipment Manufacturers: Wright D. Goss, New York; F. W. Walker, Beaver Falls, Pa.; W. M. Wood, Decatur, Ill.; William Ritter, Columbus, O.

Material and Equipment Dealers: W. T. Rossiter, Cleveland; E. L. Jahncke, New Orleans; John E. Doyd, Philadelphia; M. T. Bannigan, Utica.

Financial Bond, Insurance and Real Estate Organizations: Willis Booth, New York; Harry A. Wheeler, Chicago; Irving B. Hiett, Toledo; James T. Hoveland, Philadelphia; Charles A. Hennery, New York.

Public Utility Construction: Gano Dunn, New York; Francis Blossom, New York; Jos. Alexander, Cleveland; C. H. Markham, Chicago.

Federal, State, County and Municipal Construction Departments: Rudolph P. Miller, New York; Chas. Upham, Raleigh, N. C.; J. M. Gries, Washington, D. C.; W. T. Sargent, New York.

Federated Associations: Wm. F. Chew, Baltimore; Walter Klie, Cleveland; E. W. Reaugh, Cleveland; G. C. Mills, Webster City, Ia.

The first meeting of the Executive Board was held in New York, June 23, at which time Mr. Roosevelt formally took office.

Methods of Erecting 410 Ft. High Radio Towers

In the recent erection of the towers for the New York Radio Central Station at Rocky Point, L. I., some very unusual methods were used. Twelve towers have been erected and the plan calls for the erection of sixty more some time in the future. There are to be twelve wings of six towers each, all connecting to a central radio center. When completed, it will be, it is said, the largest and most complete station in existence and will be able to communicate with all parts of the world. The erection methods are described as follows in The Contract Record.

The towers are square in plan, 410 ft. high with a 150-ft. cross-arm on the top. The base of the tower is 60 ft. square at the bottom, 70 ft. high and 38 ft. square at the top. The height of the base made is suitable for erection by an 80 ft. gin-pole composed of four 20 ft. sections of 10 in. gas pipe. Each of the four legs was supported by a guy wire, running back diagonally, until they could be joined together and become self-supporting.

The body of the tower was composed of 10 panels of 30 ft. and one of 40 ft. It is 38 ft. square at the bottom and 10 ft. at the top. This part of the tower was erected by means of a floating gin-pole, the same 80-ft. section of gas pipe being used with special fittings being placed on both ends. In erecting the first six panels the tower legs were erected singly and the bracing in panels. In the upper five panels, where the steel was lighter two tower legs and a panel of bracing were erected at the same time. The heaviest piece in the body of the tower was 3,400 lb., but the heaviest lift was 4,850 lb.

The erection of the cross-arm was the most difficult problem and a very ingenious method was used. It was thought very inadvisable to put any eccentric loads on the tower and the erection of the cross-arm by the cantilever method would have been unsafe and very costly due to the height above ground and the top of the tower being only 10 ft. square. The rigging devised to erect the cross-arm a two-boom guy derrick with the gin-pole acting as the mast. Each half of the cross-arm was assembled on the ground and connected to the booms on the top of the tower. Each half was then raised simultaneously off the ground and thus balanced each other. One was raised to its proper position and bolted so that its weight was still balancing the other half which was then raised into position. Each half of the cross-arm weighed 16,000 lb.

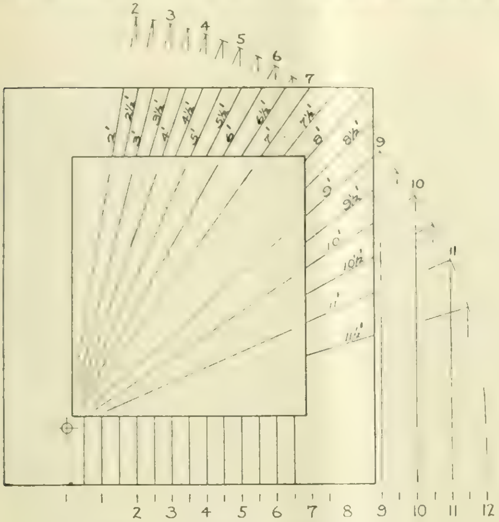
The bracing used throughout consisted of rolled angle sections in place of the usual rod bracing of the previously constructed radio towers. The lower 250 ft. part was riveted and painted while the remaining 160 ft. height and the cross-arm were bolted and galvanized. All rivets were ¾ in. in diameter, the galvanized portion being bolted with sherardized bolts which were checked with a diamond point to lock them.

Device for Spacing Reinforcing Bars in Concrete Slabs

W. A. Green, designing engineer of the Trussed Concrete Steel Co., Ltd., London, gives the following notes and diagram in a recent issue of Concrete and Constructional Engineering, London:

It is sometimes necessary to set out on a drawing reinforcement spaced at regular intervals. The illustration shows a device which has proved useful. It consists of a frame constructed of thin celluloid which is laid on the drawing with the bottom edge at right angles to the reinforcing bars.

If a scale is placed so as to pass through the point O and lie along the inclined line marked with required spacing of the bar centers, the foot marks on the scale will show on the drawing the position of the centers of the reinforcing bars, and if the unit mark on the scale coincides with the position of the first bar the number of bars can be read from the scale without calculation.



Device for Spacing Reinforcing Bars.

The lines drawn outside the frame in the illustration will help to make clear the simple construction for drawing the inclined lines, e. g., the inclined line for 5 in. centers is drawn by joining O with the point of intersection of a vertical line 5 units from O and a circle of 12 units radius with its center at O.

The device can, of course, be used for drawings made to any scale.

If the frame is made in thin cardboard the point O should be at the intersection of the inner lines of the frame at the bottom left-hand corner, but in the deviser's experience an opaque frame usually hides the portion of the drawing one wishes particularly to see.

Surface Finishing Concrete Bridge with Pneumatic Chipping Hammer

Excellent results were obtained by using a pneumatic chipping hammer for tooling concrete on the Broad St. viaduct, connecting Mount Vernon and Yonkers, N. Y. The contract called for 22,000 sq. ft. of tooling. When the time came to start this it was thought by the engineer that a better appearance would be obtained if the surface were rubbed rather than tooled. Various power machines with which carborundum stone was employed were tried, but as the concrete was about three years old and very hard, this method did not prove successful. The sand blast was next tried. It removed the outside film satisfactorily but carried the board marks back into another plane. It did not seem possible to manipulate the blast in any way to overcome this. Tooling with a pneumatic chipping hammer was then resorted to with very satisfactory results. Compressed air was supplied by a small gasoline driven air compressor which was moved along on top of the bridge as the work progressed. The tool found to give the best results considered from all standpoints was a cross (+). The surface of the spandrel walls and the recessed portions of the retaining walls were treated in this way giving a pleasing contrast.

Engineering and Executive Types in Industry

Two distinct types are constantly being recognized in industry, namely, the engineering type and the executive type.

The engineering type of man works for the solution of a single technical or engineering problem and is concerned with the determination of the solution rather than the application of that solution to practical activities. The true type has the capacity to concentrate continuously on a single problem until the solution has been reached. He is interested in the determination of cause and effect and the laws that govern phenomena. He is disposed to be logical, analytical, studious, synthetical and to have an investigating turn of mind. The predominating characteristic that distinguishes him from the executive is his ability to concentrate on one problem to the exclusion of others for a protracted period, to become absorbed in that problem and to free his mind of the cares of other problems. He does not submit readily to the routine performance of a given quantity of work. He deals with laws and abstract facts. He works from textbooks and original sources of information. Such men are Edison, Steinmetz, the Wright brothers, Curtiss, Bell, Pupin, Fessenden, Browning. These men are the extreme of the engineering type, they have enormous imagination, initiative, constructive powers.

The executive type takes the conclusions of the engineer and the laws developed by the engineer and applies them to the multitude of practical problems that come before him. His chief characteristic is that he works with a multitude of constantly changing problems at one time. He concentrates on one problem after another in rapid succession. In many instances he has not the time to obtain all of the facts and he must arrive at a conclusion or make a decision based upon partial knowledge. He must rapidly assimilate available facts and fill in what is lacking from the ripeness of his own experience, frequently calling upon his powers of judgment, and even intuition. He is a man of action, boldness, ingenuity, force, determination, aggressiveness, courage, decision; he is possessed with a desire to get things done, impatient of delay. He works from a handbook, a newspaper or nothing at all. Such men are Schwab, Goethals, Pershing, Farrell, Hindenburg, Hoover.—J. E. Otterson, President Winchester Repeating Arms Co., in Mechanical Engineering.

Standardization in the Building Industry

Some contractors have made time studies and know approximately the number of brick a good workman should lay in eight hours for different types of wall and under different conditions, but the great majority operate on guesses only.

Standards of work should be determined for many different operations. We should know more about the laying of hollow tile, the work of the tile setter, the time required for performing certain units in framing, roofing and siding.

We cannot establish standards for work as long as the builder fails to schedule his work. One of the first essentials is to have materials on hand. If the management fails to order the work properly, if it makes the carpenter wait for the framing, if it makes him walk 100 feet to get the studding, you can neither expect results nor establish standards in which both an employer and employee will have confidence.

With the closer co-operation of every element in the construction industry, we will soon speak the same language. We must accept a common terminology. Furthermore, cost accounting must be more uniform than it is today. What two producers, what two vendors, or what two contractors have the same definitions for ledger accounts? Many will say that all agree. You think the other fellow uses your terms and he in turn thinks that you use his. I have examined many sets of books and found that even among those who claim to have the same system that the definitions of accounts differ.

When contractors compare with each other, I become skeptical. Why? Because I have so often found that the definitions of labor accounts vary widely, that contractors are talking about entirely different things. The account may bear the same name but the items charged to the account are not the same. I have seen trucks charged to a single job or to the month's expense, while others have charged it to equipment. Some make an annual depreciation charge and others never charge the expense to operation.—Dr. John M. Gries, Chief, Division of Buildings and Housing, U. S. Department of Commerce, in address before convention of National Builders' Exchange.

Housing Shortage Estimated at 2½ Years Production

Despite the increased building activity in the United States during the last six months the housing shortage for the country as a whole was estimated as somewhat more than 2½ years' production by John Ihlder, manager of the Civic Development Department of the Chamber of Commerce of the United States before the National Conference of Social Work. According to Mr. Ihlder the situation is not the same in all American cities. In some cities the shortage is estimated as nearly four years behind, while in others it is approximately 1½ years, or even less.

Mr. Ihlder stated that from the housing point of view, the most encouraging development of the past two or three years is the extension of zoning legislation in the United States. "Just before the war zoning gripped our imagination and as soon as peace returned American cities began to apply it. Today some 60 cities have or are drafting zoning regulations. Because of these zoning regulations they are keeping in their residence districts the open spaces which are the fundamentals of good housing."

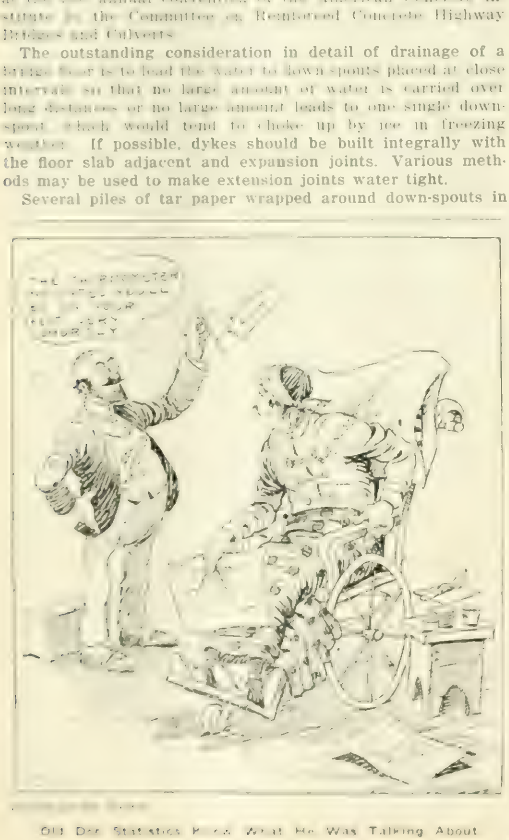
Drainage Provisions for Concrete Bridges

The following notes are taken from the report submitted at the last annual convention of the American Concrete Institute by the Committee on Reinforced Concrete Highway Bridges and Culverts.

The outstanding consideration in detail of drainage of a bridge floor is to lead the water to down-spouts placed at close intervals so that no large amount of water is carried over long distances or no large amount leads to one single down-spout which would tend to choke up by ice in freezing weather. If possible, dykes should be built integrally with the floor slab adjacent and expansion joints. Various methods may be used to make extension joints water tight.

Several plies of tar paper wrapped around down-spouts in concrete sections will provide for possible expansion of the metal drain pipe. Icicles can be prevented to large extent by placing perforated copper baskets filled with rock salt at the top of each drain pipe.

In retaining wall construction, where backfill carries an unusual amount of water, trench drains built up around the weep holes at ground level will facilitate flow of drainage. Weep holes should be made large, and so that they can be readily cleaned.



Old Doc Statistics Knows What He Was Talking About

A 1200-Year-Old Slate Roof.—According to Oliver Bowles, Mineral Technologist, U. S. Bureau of Mines, there is a record of a chapel in Bedford-on-Avon, in Wiltshire, England, roofed with slate in the 8th century. After 1200 years of climatic exposure the roof is moss covered but in good conditions.

Personals

L. O. Hopkins, who a year or so ago was transferred from the Strauss Bascule Bridge Co. to the Strauss Yielding Barrier Co., is no longer connected with the latter company and thus his relations with both companies have been entirely severed. This completes the reorganization of the engineering staff of the Strauss Bascule Bridge Co., which comprises J. B. Strauss, president and chief engineer; C. A. Ellis, vice-president and engineer in charge of design; P. L. Kauffman, assistant secretary and contracting engineer; C. E. Paine, contract engineer, and the staff of experts in bridge engineering, which the company has maintained. The New York office, formerly in charge of Mr. Vincent, has been discontinued and new eastern offices opened at Room 603, Albee Bldg., Washington, D. C., in charge of J. C. Eversman.

F. S. Altman has been appointed district engineer in charge of the Minneapolis office of the Portland Cement Association, to succeed W. E. Hart, who has been transferred to the general office as manager of the structural bureau. The Minneapolis office, located in the Metropolitan Bank Bldg., has charge of association work in Minnesota and North and South Dakota. Mr. Altman has been connected with the Portland Cement Association for the past 2½ years and has been engaged principally in Kansas. Prior to joining the association staff he was in the Corps of Engineers, U. S. Army, and city engineer of Atchison, Kans.

L. S. Trainor has been appointed district engineer in charge of the Illinois district of the Portland Cement Association, to succeed C. M. Powell, resigned. This office, located in the Conway Bldg., Chicago, has charge of association work in Illinois. Mr. Trainor has been connected with the Portland Cement Association for the past three years, and has been engaged principally in southern Illinois. Prior to joining the association staff he was county superintendent of highways, Marion County, Illinois, and city engineer of Centralia, Ill.

William Hooker, for several years engineer for the city park department of Hibbing, Minn., has resigned to go with the Charles Foster Consulting Engineering Co. of Duluth.

C. Howard Crane and **Kenneth Franzheim**, architects, Chicago, have opened a branch office in Houston, Tex.

James O. Wanzer of Santa Cruz, Calif., has been appointed city manager of Marysville, Calif.

Henry B. Crawford, a contractor, has been elected city manager of Columbus, Ga.

James I. Vincent has been appointed eastern representative of the Chicago Bascule Bridge Co., with offices at 30 Church St., New York. Mr. Vincent, who was graduated from the University of Michigan in 1896, spent several years with bridge fabricating companies and railroads. In 1901 he joined the Scherzer Rolling Lift Bridge Co., where from 1905 to 1912, he was in charge of their New York office, except during 1908, which year he spent abroad in charge of the construction of a bridge in Burma and in obtaining orders in Europe. From 1912 until very recently Mr. Vincent was eastern representative of the Strauss Bascule Bridge Co., in charge of the New York office.

Frank B. Hunter, an architect, has been appointed architectural advisor to the city administration of Indianapolis, Ind.

John H. Parker, of the firm of Parker, Thomas & Rice, architects, Boston, Mass., has been appointed a member of the Municipal Art Commission of that city.

Obituaries

Z. E. Moncrieff, a contractor, died last month at his home, 427 Ogden Ave., Denver, Colo., aged 61.

Wm. M. Courtis, a well known mining engineer, died June 19 at his home, 620 Parkview Ave., Detroit, Mich., aged 80.

Russell Condon, a contractor, died June 18 at his home, 3634 South 26th St., Omaha, Neb., aged 52.

George Wievel, city engineer of Platteville, Wis., died recently.

Joseph P. Duff, for the past 20 years assistant city engineer of Superior, Wis., died June 16 at his home, 1609 Belknap Ave., Superior, aged 57.

Walter L. Hull, city engineer of Orange, N. J., died June 20.

Alvin E. Gravelle, of Los Angeles, Calif., a civil engineer, died recently. He was a graduate of McGill University. Mr. Gravelle was assistant bridge engineer of Cleveland for several years and previous to that was designer of the Grand avenue bascule bridge at Milwaukee.

Maj. John A. Bensel, consulting engineer, 111 Broadway, New York City, died June 19 at his home in Bernardsville, N. J., after an illness of several months. Maj. Bensel was commander of the 15th Engineer Battalion during the World War. He was former chief engineer of the Dock Department of New York City and later state engineer of New York. Since 1919 Maj. Bensel had been a consulting engineer to the New York and New Jersey vehicular tunnel commissions. He also was consulting engineer in a number of municipal projects in New York City.

Industrial Notes

The Fulton Co., manufacturers of heating specialties, Knoxville, Tenn., has been reorganized. The new officers of the company are W. M. Fulton, president and treasurer; Warren Webster, vice-president; C. N. Mynderse, executive manager, and Henry [illegible], secretary.

Bids Asked

Roads-Streets

Calif. Los Angeles—Until 10 a. m., July 3, by board of public works, city hall, for the following street work: Curbs, gutters, sidewalks, grading and piled roadway on Maryland St. from the northwesterly curb line of Westlake Ave. to the southeasterly line of Alvarado St., and portions of the first alley west of Westlake Ave. and Alvarado St.

Calif., Sacramento—Until 2 p. m., July [illegible], by California highway commission, Room 515 Forum Bldg., for Portland cement conc. paving in Santa Barbara county, approx. 10.8 mi., Portland cement conc. 3.[illegible] mi., and Portland cement conc. shoulder and asphalt conc. surface, 5.6 mi. in Orange county. Austin B. Fletcher, State Highway Engineer.

Colo., Denver—Until 2 p. m., July 5, by J. W. Johnson, Dist. Engineer, U. S. Dept. of Agriculture, 301 Custom House, Denver, Colo., for constructing the Aladdin-Hulett National Forest Road Project, County of Crook, State of Wyoming, approx. 2.585 mi. Work includes the following items: 11.[illegible] acres of clearing and grubbing, 6,036 cu. yds. rock excavation, 22,037 cu. yds. common excavation, 4,000 station yards overhaul, 2.585 mi. finishing, 67 cu. yds. cement rubble masonry, 332 lin. ft. 15-in., 180 lin. ft. 18-in., 174 lin. ft. 24-in. corrugated metal culverts, 745 lin. ft. rustic guard rail, 1 20-ft. log span bridge in place, and 1,500 sq. ft. log cribbing.

Colo., Denver—Until 2 p. m., July 7, by state highway department, Denver, Colo., for construction of Colo. Federal Aid Project No. 7-C, 10.526 mi. of grading.

Fla., Quincy—Until July 18, by J. P. Smith, City Clerk, for paving certain streets, with necessary curbs and gutters, 21,800 sq. yds. pavement, 16,075 lin. ft. conc. curb. J. B. McCray Eng'g Co., Atlanta, Ga.

Del., Wilmington—Until noon, July 5, by Chas. E. Grubb, State Highway Comm'r., for the construction of a conc. pavement on Hamburg road.

Ill., Belleville—Until 10 a. m., July 5, by board of local improvements of the city of Belleville for improving Pennsylvania Ave. by grading and paving and constructing necessary drainage structures; Virginia Ave. by grading and paving and constructing necessary drainage structures, also Douglas Ave. and McKinzie place.

Ill., Moline—Until 10 a. m., July 3, by board of local improvements, Moline, Robt. M. Bendell, secretary, for improving Eighteenth Ave. from 16th to 18th street, and Eighteenth street from 17th to 18th Ave., Eighteenth street A. from 16th to 18th Ave., and Eighteenth street B. from No. line of lot 14 Bausch's First Addition, to Eighteenth Ave., by grading, draining, curbing and paving with asphaltic concrete.

Ill., New Lenox—Until 2 p. m., June 29, by Seward Batson, town clerk, for construction of 5,270 ft. of macadam paving.

Ill., Peoria—Until 10 a. m., June 30, by county clerk, supervisor's room, court house, for furnishing approximately 500,000 gals. road oil. W. E. Emery, county supt., highways.

Ill., Rock Island—Until 9 a. m., July 1, by H. M. Schriver, Mayor, for resurfacing Third Ave. from Ninth St. to Thirteenth St., with asphaltic concrete.

Ill., Springfield—Until 10 a. m., July 6, by department of public works and buildings, division of highways, Springfield, Ill., for construction of highways, of Portland cement conc., monolithic brick, bituminous-filled brick, bituminous conc. with binder course and bituminous conc. without binder course, as follows: Macon county, 6.33 mi.; Greene county, 3.64 mi.; Peoria county, 3.21 mi.; Peoria county, 2.86 mi.; Hamilton county, 4.82 mi.; Marshall county, 4.62 mi.; Franklin county, 4.13 and 4.60 mi.; Williamson county, 1.8 and 10.46 mi.; Bond-Fayette counties, 0.88 mi.; McLean county, 6.49 mi., 5.21 mi. and 5.28 mi.; Woodford county, 3.14 mi.; Tazewell county, 5.28 mi.; Clinton county, 5.71 mi.; Marion county, [illegible] mi. and 3.61 mi.; Hancock county, 3.81 mi.; Winnebago county, [illegible] mi.; Cook county, 6.85 mi.; Macoupin county, [illegible] mi.

Ind., Angola—Until 2 p. m., July [illegible], by commissioners of Steuben county, Angola, Ind., for the construction of a gravel road, [illegible] ft. in length, to be known as the H. L. Smith road. Estimated cost, [illegible]. Frank O. Watkins, Auditor.

Ind., Bloomfield—Until 2 p. m., July 5, by commissioners of Greene county, at Bloomfield, Ind., for the construction of two roads to be known as the John Hess et al road, and the J. Guy Butcher road. Herschel [illegible], Auditor.

Ind., Bloomington—Until 2 p. m., July 5, by Horace Blakely, auditor, Monroe county Court House, Bloomington, for grading, draining, paving with gravel, macadam cement, brick or stone a certain highway.

Ind., Boonville—Until 2 p. m., July 5, by commissioners of Warrick county, Boonville, Ind., for the construction of a broken stone and gravel road, to be known as the Carter road in Boone twp. Estimated cost, $17,747.

Ind., Cannelton—Until 1 p. m., July 3, by commissioners of Perry county, Cannelton, Ind., for the construction of two gravel or crushed limestone roads, 5.6 and 3.02 mi. in length; estimated costs, $34,944 and $20,056. T. A. Lasher, Auditor.

Ind., Columbia City—Until July 6, by board of commissioners of Whitley county, Columbia City, for the improvement of a certain highway, 23,484 ft. in length, by grading, draining and paving with gravel, estimated cost, $13,096. Walter K. Burwell, Auditor.

Ind., Columbia City—Until July 6, 1922, by the board of commissioners of the county of Whitley, Columbia City, Ind., for the following highway improvements: 10,600 ft. of gravel paving, estimated cost, $8,855, in Troy twp.; 5,920 ft. of gravel paving in Troy twp., estimated cost, $5,965. Walter K. Burwell, Auditor.

Ind., Crown Point—Until 1 p. m., July 5, by board of commissioners of Lake County, Ind., Geo. M. Foland, Auditor, for road patching, carpet coat and penetration work and materials for gravel road repair.

Ind., Ft. Wayne—Until 7:30 p. m., June 30, by board of public works, Andrew J. [illegible], sec., city hall, for construction of the following street improvements: Paving of French Ave., from west line of Webster St. to east line of Hoagland Ave., paving of Gamper Ave. from the west line of Webster St. to east line of Hoagland Ave., paving of Burgess St. from east line of Sherman St. to east line of St. Mary's Ave.

Ind., Greencastle—Until 10 a. m., July 3, by commissioners of Putnam county, Greencastle, Ind., for the construction of a gravel road in Floyd twp., 5,656 ft. in length, estimated cost, $15,500. R. E. Knoll, Auditor.

Ind., Indianapolis—Until 10 a. m., June 30, by commissioners of Marion county, Indianapolis, for the construction of a road in Center and Wayne twps., to be known as the Lloyd W. Durbin, et al, road, estimated cost, $85,252. Leo K. Fesler, Auditor.

Ind., Kentland—Until 1 p. m., July 3, by commissioners of Newton county, Kentland, Ind., for the construction of a gravel road in Jackson twp., 3 mi. in length; estimated cost, $10,959. John G. Davis, Auditor.

Ind., Knox—Until noon, July 3, by commissioners of Starke county, Knox, Ind., for the construction of two gravel roads to be known as the R. R. Whitney road in Washington twp., and Baughman and Bliss road in Wayne and California twps. Henry A. Smith, Auditor.

Ind., Lawrenceburg—Until noon, July 3, by commissioners of Dearborn county, Lawrenceburg, Ind., for the construction of a broken stone road in York twp., 31,189 ft. in length, to be known as the Jacob Hoffmeier, et al, road. A. E. Jackson, Auditor.

Ind., Logansport—Until 10 a. m., July 5, by commissioners of Cass county, Logansport, Ind., for the construction of two gravel roads, estimated costs, $23,828 and $25,209. Harry M. Gardner, Auditor.

Ind., Monticello—Until 10 a. m., July [illegible], by commissioners of [illegible] county, at Monticello, Ind., for the construction of a gravel road [illegible] ft. in length, estimated cost, $10,3[illegible]. [illegible], Auditor.

Ind., Princeton—Until [illegible] July 12, by board of commissioners of Gibson county, Princeton, Ind., for the improvement of 6,187 ft. of highway [illegible] the Herman G. [illegible] road [illegible] grading and paving with stone [illegible] other paving material.

Ind., Princeton—Until [illegible] July 12, by board of commissioners of Gibson county, Princeton, Ind., for the improvement of 13,200 ft. of a certain highway known as the J. Russell [illegible] road by grading, draining and paving with stone, gravel or other paving material. Alfred M. Johnson, Auditor.

Ind., Princeton—Until 11 a. m., July 12, by board of commissioners of Gibson County Court House, Princeton, Ind., for grading, draining and paving with stone, gravel or other material [illegible] mi. of highway, known as the Victor [illegible] Road.

Ind., Princeton—Until 11 a. m., July 12, by board of commissioners of Gibson County, Court House, Princeton, Ind., for grading, draining and paving with stone, gravel or other material 20,056 ft. of highway known as the Herman W. Barrett Road. Alfred M. Johnson, County Auditor.

Ind., Rennselaer—Until 2 p. m., July 3, by commissioners of Jasper County, Rensselaer, Ind., for the construction of a road to be known as the C. W. Dewey, et al, Road. S. C. Robinson, Auditor.

Ind., Rockville—Until 1 p. m., July 5, by board of commissioners of Parke County, Rockville, Ind., for grading, draining and paving with gravel 3,600 ft. of a certain highway known as the Rockville and Catlin Road. Ralph E. Porter, Auditor.

Ind., Salem—Until 2 p. m., July 3, by commissioners of Washington County, Salem, Ind., for the construction of two roads, 21,071 ft. and 11,817 ft. in length, respectively, to be known as the Pekin and Lowman Road and the Organ Springs and Adams School House Road; estimated costs, $27,613 and $12,409. Eli E. Batt, Auditor.

Ind., Shelbyville—Until 10 a. m., July 5, by commissioners of Shelby County, Shelbyville, Ind., for the construction of three gravel roads, 9,446, [illegible]626 and 5,330 ft. in length. Walter W. Leslie, Auditor.

Ind., Shoals—Until 2 p. m., July 3, by commissioners of Martin County, Shoals, Ind., for the construction of four unit county roads, 7,439, [illegible], 18,383 and 17,765 ft. in length. Bertie L. Newland, Auditor.

Ind., Tipton—Until 10 a. m., July 3, by commissioners of Tipton County, Tipton, Ind., for the construction of a gravel road, 1,926 ft., estimated cost, $2,242 ft. Chas. Grimshaw, Auditor.

Ind., Versailles—Until [illegible] p. m., July 3, by commissioners of Ripley County, at Versailles, Ind., for the construction of two roads, 6,266 and 10,776 ft. in length. W. L. Robinson, Auditor.

Ind., Wabash—Until 10 a. m., July 5, by commissioners of Wabash County, Wabash, Ind., for the construction of a hard surface material road in Chester Twp., 2,640 ft. in length. Ben Banister, Auditor.

Ind., Washington—Until 2 p. m., July 3, by commissioners of Daviess County, Washington, Ind., for the construction of a road in Bogard Twp., to be known as the Wm. T. Barlow, et al, road; estimated cost, $21,241. Dan'l L. Myers, Auditor.

Ind., Williamsport—Until 9 a. m., July 3, by commissioners of Warren County, Williamsport, Ind., for the construction of a gravel road in Pike Twp., 4,422 ft., estimated cost, $11,900. W. H. Stephens, Auditor.

Ia., Davenport—Until 2 p. m., July 3, by Harry W. Phillips, Supt. of Public Construction, City Hall, Davenport, Ia., for improving two alleys by excavating and paving with concrete.

Ia., Des Moines—Until 9 a. m., July 3, by city council of Des Moines, A. E. McGlothlen, city clerk, for curbing 3,791 lin.

ft. straight curb of York St. with Portland cement. 3,913 lin. ft. of West 11th St. [illegible] East 12th St.

Ia., Des Moines—Until 9 a. m. [illegible] by city council of Des Moines, A. [illegible] Garrison, city clerk, for curbing [illegible] straight curb, Portland cement, a [illegible] of [illegible] 1,750 lin. ft., West 17th St. straight curb, Portland cement, 1,160 lin. ft. East 12th St., **straight curb**, Portland cement, 2,124 lin. ft.

Ia., Dubuque—Until 2 p. m., June [illegible], by City Manager, Dubuque, Ia., for furnishing labor and material for resurfacing [illegible] ft. of street with bituminous macadam, and [illegible] ft. with **Asbestophalt.**

Md., Baltimore—Until noon, July [illegible], by state road commission, **Room 601**, Garrett Bldg., Baltimore, for constructing the following sections of state highway: Carroll county, [illegible]; Frederick county, 0.4 mi. [illegible]; Howard county, 1.21 mi. [illegible]; St. Mary's and Charles counties, 4 mi. [illegible].

Md., Baltimore—Until 11 a. m., June 21, by Board of Awards, office of City Register, for grading and paving with concrete [illegible], also for grading and **paving** with concrete [illegible] alleys as [illegible] in [illegible] Nos. [illegible] and [illegible].

Mass., Boston—Until 2:30 p. m., [illegible], by department of public works, division of waterways and **public lands**, for [illegible] for the construction of an [illegible]. Work [illegible] 2,250 [illegible] ft. [illegible]. Frank W. Hodgdon, Chief Engineer.

Mich., Adrian—Until 10 a. m., July 12, by Board of County Road Commissioners, Lenawee county, court house, Adrian, Mich., for improving 1.420 mi. of road by shaping, constructing necessary drainage structures and surfacing with waterbound macadam.

Mich., Ann Arbor—Until 7:30 p. m., by [illegible] Reynolds, City Clerk, for the construction of conc. curb and gutter. **(Advertisement in this issue.)**

Mich., Bessemer—Until 10:30 a. m., July 7, by board of county road commissioners, Gogebic county, Court House, Bessemer, for improving [illegible] mi. road by surfacing with bituminous macadam, shaping and **constructing drainage structures.**

Mich., Cadillac—Until 1:30 p. m., June 30, by state highway department, Haskins Block, Cadillac, for improving [illegible] mi. of road in [illegible] county.

Mich., Crystal Falls—Until 10:30 a. m., July 11, by board of County Road Commissioners, **Iron County, Court House,** Crystal Falls, Mich., for improving 11.275 mi. of road, three sections, by shaping, constructing necessary drainage structures **and surfacing with bituminous macadam and one-course gravel.**

Mich., Escanaba—Until 10:30 a. m., June 29, by board of county road commissioners, Delta county, Court House, Escanaba, **Mich., for surface treating with bituminous** material 13.261 mi. of road in Garden and Nahma twps.

Mich., Gladstone—Until 10:30 a. m., June 29, by board of county road commissioners, Court House, Escanaba, Mich., for improving 1.87 mi. of road in the city of Gladstone. Work consists of shaping, constructing and necessary drainage structures and surfacing with conc. and roughened conc.

Mich., Grand Rapids—Until 9:30 a. m., June 6, by board of county road commissioners, County Bldg., Grand Rapids, for improving 2.64 mi. of road in Kent county.

Mich., Hastings—Until 9 a. m., July 7, by Board of County Road Commissioners, Barry County, Court House, Hastings, Mich., for improving 6.85 mi. of road, two sections, by shaping, constructing necessary drainage structures and surfacing.

Mich., Houghton—Until 11 a. m., June 30, by board of county road commissioners of Houghton county, Court House, **Houghton,** Mich., for surface treating 4.175 mi. of road. Frank F. Rogers, State Highway Commissioner, Houghton, Mich.

Mich., Iron Mountain—Until 2 p. m., July 6, by board of county road commissioners, Dickinson county, Court House, Iron Mountain, Mich., for improving 4.34 mi. of road in Dickinson county, by shaping, constructing necessary drainage structures and surfacing with gravel.

Mich., Jackson—Until [illegible] p. m., July 6, by Board of County Road Commissioners of Jackson county, [illegible], Jackson, Mich., for improving [illegible] mi. of road.

Mich., Jackson—Until 9 a. m., June 29, by board of county road commissioners, 132 W. Ganson St., Jackson, Mich., for improving 2.912 mi. of road in Jackson county. Frank F. **Rogers, State Highway Commissioner,** Lansing, Mich.

Mich., Marshall—Until 1:30 p. m., June 30, by board of county commissioners of Calhoun county, Court House, Marshall, Mich., for improving 2.302 mi. of road by shaping, constructing necessary drainage structures and surfacing with reinf. conc.

Mich., Marysville—Until 1 p. m., July 6, by Board of County Road Commissioners of St. Clair County, Court House, Port Huron, Mich., for improving 0.947 mi. of road in the village of Marysville.

Mich., Munising—Until 10:30 a. m., July 5, by board of county road commissioners, Alger county, Court House, Munising, Mich., for improving 2.034 mi. of road in Alger county by shaping, constructing necessary drainage structures and **surfacing** with bituminous macadam.

Mich., Sandusky—Until 1 p. m., July 11, by Frank F. Rogers, State Highway Comm'r, Lansing, Mich., for improving 1.241 mi. of road Sanilac county by grading, draining and surfacing gravel and conc.

Mich., White Pigeon—Until 1:30 p. m., June 29, by Village Clerk, Council Rooms, White Pigeon, for improving 0.367 mi. of road in St. Joseph county by shaping, constructing, drainage structures and surfacing.

Mont., Helena—Until 10 a. m., June 29, by the state highway commission, Capitol Bldg., Helena, **for the grading** and surfacing, together with all necessary drainage structures, of a distance of 4.87 mi. on Butte-Anaconda road, Federal Aid Project No. 70 "B." John N. Edy, Chief Engineer.

N. J., Elizabeth—Until 2:30 p. m., July 5, by Board of Chosen Freeholders, Court House, Elizabeth, N. J., for the improvement of Mountain Ave., for a total length of 3,537.60 ft. Work to include concrete curb and gutters and asphaltic concrete pavement on cement concrete base. And for the improvement of Springfield Ave., a total length of 10,274 ft., reinforced cement concrete pavement. Jacob L. Bauer, County Engineer, **120 Broad St., Elizabeth, N. J.**

N. J., Elizabeth—Until 2:30 p. m., July 5, by board of chosen freeholders, county of Union, court house, Elizabeth, N. J., for improvement of Springfield Ave. borough of New Providence, a total length of 10,274 ft.

N. J., South Orange—Until 8 p. m., June 30, by Board of Trustees, village of South Orange, for the improvement of Hassel Terrace, Marshall Court and Ridgewood Road. Ira T. Redfern, Village Engineer, **South Orange, N. J.**

N. J., Tuckerton—Until 11 a. m., July 7, **by J. M. Abbott, County Engineer, State** Highway Dept., Toms River, N. J., for the **construction of State Highway, Route** 4, Sec. 18, in the borough of Tuckerton.

N. Mex., Raton—Until 8 p. m., June 30, by City **Council, at City Hall, Raton, for** the construction of pavement, curb and gutter, approximately 47,895.12 sq. yds. **paving. Mrs. Alfred Jelfs, City Clerk.**

N. Y., Albany—Until 3 p. m., July 3, by board **of contract and supply, City Hall, for improvement of Tivoli St., from Broad**way westerly 1,460 ft.; improvement of Forest Ave. from New Scotland Ave. to Helderberg Ave., Kent St. from Partridge St. to Main Ave., repaving of Morris St. from S. Lake Ave. to Quail St.

N. C., Burlington—Until noon, June 29, by city of Burlington, for the construction of approx. 12,000 sq. yds. conc. sidewalk with necessary grading. The Ludlow Engineers, Winston-Salem, N. C.

O., Akron—Until noon, July 5, by M. P. Tucker, Director of **Public Service, 3rd** floor Delaware Bldg., Akron, O., for paving seven streets and avenues and grading and constructing sidewalks on two streets.

O., Genoa—Until noon, June 29, by Village Clerk Earl Camper for paving of West St. from north line of First St. to first alley north of Sixth St., approximately 5,600 sq. yds. bituminous pavement including grading, pipe sewers, manholes, **curbing and other appurtenances.**

O., Hamilton—Until 10 a. m., July 7, by board of county commissioners, C. Z. Moore, Sec.-Clerk, for construction of culverts and graveling road at Smith-[illegible] farm.

Ore., Portland—Until 10 a. m., June 29, by state Highway **Commission, Multnomah** County Court House, Portland, for the following road work: Douglas County, 7 mi. rock surfacing, 18,000 cu. yds.; Tilla**mook County, 3.3 mi. rock surfacing, 7,500** cu. yds.; Umatilla County, 13.5 mi. grading and rock surfacing, 82,000 cu. yds. excavation; Wallowa County, 7.9 mi. grading and rock surfacing, 70,000 cu. yds. exca**vation.**

Pa., Scranton—Until 11 a. m., June 29, by City Controller, for furnishing and delivering f. o. b. cars at Municipal Asphalt **Plant, Providence Rd. and W. Olive St.,** 300 tons of 2,000 lbs. each, asphaltic cement, delivered in tank cars.

S. D., Beresford—Until 7:30 p. m., June 29, by Dakota Engineering Co. for approximately 12,300 sq. yds. pavement.

Tex., Georgetown—Until 2 p. m., June 29, by Geo. Keahey, City Clerk, for improvement of **certain streets. W. N. Harris,** City Engineer.

Tex., Gonzales—Until 2 p. m., July 12, by Hon. J. C. Romberg, county judge, county clerk's office, for the improvement of 9.2 mi. **of section C. F. A. P. 138, State** Highway No. 29, by clearing and gravel **surfacing, with work incidental thereto.**

Tex., Houston—Until noon, July 3, by secretary of City of Houston, **for the fol**lowing street paving: Travis St. from [illegible] St. to South End, Villa St. from Main St. to Louisiana St., Wichita St. from Travis St. to South End, Milan St. from Villa St. **to Portland St.**

Wash., Olympia—Until 10 a. m., July 11, by State Highway Committee, for grading and draining about 0.75 mi. of Pacific Highway in Lewis County, clearing, grading and draining about 1 mi. Pacific Highway, south of Castle **Rock, Cowlitz County.**

Wash., Seattle—Until 10 a. m., June 30, by Seattle Board of Public Works, R. 234 **County-City Bldg., by grading and paving** with suitable material, constructing conc. or armored conc. curbs, reconstructing all sewers and **gutters with such appurte**nances as may be necessary **for the proper** sewage, drainage, water service and fire protection, also in some cases constructing conc. sidewalks, portions of thirty streets **and alleys.**

W. Va., Charleston—Until 10 a. m., June 11, by state road commission, Kanawha **county court house, Charleston, for the** construction of 2.35 mi. of grading and drainage structures, Hughes Creek to Lock 2. Division Engineer, Fayetteville, W. Va.

Wis., Superior—Until 1:30 p. m., July 6, for the improvement and pavement of **Hammond Ave. from south line of N. Third** Ave. to north line of Broadway St.

Ont., Toronto—Until noon, July 7, by **W. A. McLean, Deputy Minister of High**ways, Toronto, for approx. 3 mi. concrete **pavement, twp. of Scarboro; 4½ mi. macadam roadway, twp. of Ernesttown;** 5¼ mi. macadam base course, twp. of **Leeds; 5¾ mi. macadam base course, twp.** of Leeds and Lansdowne; 5¾ mi. macadam base course, twp. of North Elmsley; 6⅓ mi. macadam base course, twp. of Ramsey; 1½ mi. macadam base course, twp. of Thurlow; 2¾ mi. grading and macadam base, twp. of Ameliasburg, and grading in twps. of Scarboro, Townsend and Woodhouse. **Also concrete abutments and** bridge **floors in twp. of Hope.**

Ont., Toronto—Until noon, July 3, by **Frank Barber, Township Engineer, 40 Jar**vis St., Toronto, for construction of bi**tuminous macadam pavement on Dunvegan** Rd. and Forest Hill Rd., also asphalt pavement on Normanna Ave. and grading on Bicknell Ave.

Que., Quebec—Until 1 p. m., July 7, by Minister of Roads, Government Bldg., Quebec, for constructing a gravel roadway in the parish of St. Michel of Bellechase. J. L. Boulanger, Deputy Minister.

Que., Quebec—Until 1 p. m., July 8, by Minister **of Roads, city of Quebec, for construction of a gravelled roadway on por**tions of Lambton road situated in the municipalities of the parish of St. Victor-de-Tring.

Bridges

Calif., Los Angeles—Until 10 a. m., July 7, by board of harbor commissioners, 33 City Hall, Los Angeles, for furnishing [illegible] for Badger Ave. **bascule bridge.**

Calif., Monterey—Until July 6, by county supervisors, Salinas county, for constructing bridge over Salinas River at Hilltown. Estimated cost, $100,000.

Calif., Salinas—Until July 6, by county supervisors, for construction of steel span bridge with conc. piers and abutments, 712 ft. long, across Salinas river at Hilltown. Estimated cost, $100,000.

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FROM corner-stone to cornice, the modern structures that house the nation's business are built to endure. The foundations rest on bed rock. Steel frame-work and steel girders support the weight of walls and floors. And when they are ready to be roofed the great majority of them are covered with Barrett Specification Roofs.

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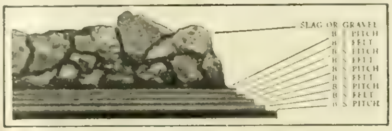

Cross-section, actual size, of Barrett Specification Roof

That we can name many roofs of this type in good condition after forty or more years of service. Their durability is *proved*, not estimated.

That they are *bonded* against maintenance expense. Barrett Inspection Service *during construction* insures strict compliance with the roofing specifications, and a Surety Company Bond absolutely protects the owner from all roof repair during the bonded period.

That moderate first cost and guaranteed freedom from maintenance make them the most economical roofs it is possible to build.

That they provide a degree of fire protection not exceeded by any other roof. They always take the base rate of fire insurance.

The Barrett Specification Type "AA" 20-Year Bonded Roof represents the most permanent roof covering it is possible to construct, and while we bond it for twenty years only, we can name many roofs of this type that have been in service over forty years and are still in good condition.

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The Surety Company Bond, absolutely protecting the owner from maintenance expense, is issued free of charge on Barrett Specification Roofs of 50 squares or larger, in towns of 25,000 or more, *and in smaller places where our inspection service is available.*

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Colo., Denver—Until 2 p. m. [illegible]

Colo., Ft. Morgan—Until [illegible] for [illegible]

Ind., Rossville—Until [illegible]

Ill., Springfield—Until [illegible] in 10 [illegible]

Ia., Sioux City—Until 2 p. m. [illegible] Sioux City [illegible] for the [illegible] Big Sioux River [illegible] county [illegible] Clerk.

Mass., Boston—Until 2 p. m. [illegible] Metropolitan District Commission [illegible] Boston, Mass., for the construction of a [illegible] over the Charles River. [illegible] Chief Engineer.

Mich., Cadillac—Until [illegible] State Highway Dept. [illegible] low truss steel span for a [illegible] Trunk Line Route No. [illegible]

Mich., Grand Rapids—Until [illegible] District Engineer, State Highway [illegible] Grand Rapids, Mich., for the [illegible] bridge, located on Trunk Line Route No. [illegible] crossing [illegible] Creek.

Mich., Grand Rapids—Until [illegible] District Engineer, State Highway Dept., Grand Rapids, for the construction of [illegible] Trunk Line Route No. [illegible] crossing [illegible] Creek.

Mich., Mt. Clemens—Until [illegible] p. m. [illegible] Macomb county board of road commissioners, Mt. Clemens, Mich., for the construction of [illegible] Salt River [illegible] F. Rogers, State Highway [illegible] Mich.

N. J., Elizabeth—Until [illegible] July [illegible] Elizabeth, N. J. [illegible] Wood Ave. [illegible]

N. J., Plainfield—Until [illegible] Plainfield, [illegible] reinf. deck [illegible]

N. Y., Binghamton—Until [illegible]

Ore., Portland—Until [illegible] State Highway [illegible]

Drainage - Irrigation

Ark., Little Rock—Until [illegible] July [illegible]

Mich., Detroit—Until [illegible]

Minn., Duluth—Until [illegible]

N. C., New Bern—Until noon, July [illegible] by [illegible] Commissioners, New Bern, [illegible] improvements [illegible] County [illegible] New Bern, N. C.

O., Toledo—Until [illegible] a. m., July [illegible] by [illegible] of Lucas County, County [illegible] for the widening of county ditch [illegible] Sawyer, County Surveyor.

Ont., Atwood—Until [illegible] p. m., July 8, by [illegible] clerk, Twp. of [illegible] Atwood, Ont., for construction of drainage [illegible] Drain and South [illegible] Improvement, estimated [illegible]

Waterworks

Calif., Berkeley—Until 4 p. m., June 29, by Board of Education, 2134 Allston Way, Berkeley, Calif., for the installation of a [illegible] and filtration plant in the Berkeley High School gymnasium. Wm. [illegible] First Nat'l Bank Bldg., San Francisco, Calif.

Ill., Moline—Until 10 a. m., June 30, by Board of Local Improvements, City of Moline, for improving 12th St. from 19th Ave. south to Velie addition by laying [illegible] water main and 8-in. sewer.

Ind., Hammond—Until 2 p. m., July 5, by Board of Public Works for furnishing [illegible] requirements in liquid chlorine of the city of Hammond, for a period of one year. E. W. Miles, Clerk, Water Dept.

Ind., Ft. Wayne—Until 10 a. m., July 6, at Auditor Angus C. McCoy's office, Ft. Wayne, for revision of water supply system, at the Irene Byron Sanitarium.

Mich., Grand Rapids—Until 2 p. m., July [illegible] by G. J. Wagner, Director of Public Service, for furnishing labor and material for the construction of an intake conduit, clear water conduit and vitrified pipe drain. C. A. Page, City Engineer.

Mich., Middleville—Until 2 p. m., June [illegible] by R. E. Harrison, Engineer, 351 Summit Cherry Bldg., Toledo, O., for erection of a steel water tank and tower.

Minn., Duluth—Until 11 a. m., June 30, by manager of the Water and Light Department for furnishing 26 hydrants.

Mass., Boston—Until 2 p. m., June 29, by Metropolitan Dist. Commission, 1 Ashburton Pl., Boston, for work in connection with the construction of a masonry tower on Arlington Heights, town of Arlington.

Minn., Royalton—Until 3 p. m., June 30, by J. J. Chihart, village clerk, for drilling and casing of one 10-in. well.

Minn., Royalton—Until 3 p. m., June 30, by J. J. Chihart, village clerk, for furnishing labor and material for the installation of a water works system. R. E. Borrowman, Consulting Engineer, St. Cloud, Minn.

Minn., St. Paul—Until 11:30 a. m., July [illegible] by H. W. Austin, Purchasing Agt., City Hall, for furnishing 12 filter operating tables for water department.

N. Y., Buffalo—Until July 11, by Commissioner Kreinheder for the construction of the substructure of new filtration plant; estimated cost [illegible]

N. Y., New York—Until 11 a. m., June [illegible] by Nicholas J. Hayes, Commr. of Water Supply, Gas and Electricity, R. 2351 Municipal Bldg., Manhattan, for transferring [illegible] and [illegible] connections on existing water mains in Ludlow, Suffolk, E. [illegible] W. [illegible] and W. 51st Streets, Borough of Manhattan.

N. Y., New York—Until 11 a. m., June [illegible] by commissioner of water supply, gas and electricity, R. 2351 Municipal Bldg., Manhattan, for furnishing and laying water mains and appurtenances in Bissel, Davidson, DeKalb, Henry, Jerome, Murdock, [illegible] Sackett, Spencer, Vincent, Waldeck and Walden Aves., E. 171st St., E. 196th St., W. 238th St., W. 262nd St., [illegible] Rd., Tudor Pl., Bronx Blvd., and Grand Concourse, Borough of Brooklyn, [illegible] Atkins, Flatlands, [illegible] and 20th Aves., Ave. T, [illegible] Richardson, Bay [illegible] E. 11th, E. 18th, E. 22nd, W. [illegible] W. 29th, W. 37th, 51st, 63rd [illegible] and 77th Sts., and in Dahill Rd., Borough of Brooklyn.

O., Akron—Until noon, July 2, by E. J. [illegible] Purchasing Agt., Delaware Bldg., [illegible] for furnishing one minimum car of [illegible]

O., Akron—Until noon, July 7, by purchasing agent of the city of Akron, for furnishing one minimum car of lead pipe.

O., Bexley—Until noon, July 10, by Board of Trustees of Public Affairs, Village of Bexley, E. D. Barnett, clerk, for construction of a cast iron water main with necessary valves and hydrants to same.

O., Cleveland—Until noon, June 30, by commissioner of purchases and supplies, R. 219, city hall, Cleveland, for supplying liquid [illegible] gas to department of public [illegible] also for furnishing sulphate [illegible] to division of water.

O., Cleveland—Until noon, June 30, by commissioner of purchases and supplies, R. [illegible] City Hall, for constructing pockets at [illegible] for division of water.

O., Geneva—Until noon, July 7, by village of Geneva, O., for the construction of a sewage treatment plant and pumping station. Burgess & Niple, Columbus, O., Engineers. W. E. Morgan, Village Clerk. (Advertisement in this issue.)

O., Toledo—Until 10 a. m., July 10, by Board of County Commissioners of Lucas County, Court House, Toledo, for furnishing material and labor to construct two water supply lines, 3,819 lin. ft. and 9,631 lin. ft. respectively.

O., East Youngstown—Until noon, July 6, by director of Public Safety and Service for furnishing the following supplies to East Youngstown water works department: [illegible] tons more or less of B. & S. cast iron water pipes, 6 in. in diameter; [illegible] tons more or less of 6-in. specials, 10 tons more or less of pig lead; 25, more or less, fire hydrants; 40, more or less, 6-in. valves; 20, more or less, valve boxes; 300 lbs. [illegible] John Lisko, director.

Wyo., Basin—Until July 7, by D. C. Lovel, Town Clerk, for extension to filtration plant, estimated cost, $10,000. Prince Nixon Engrg. Co., Omaha, Neb.

Sewerage - Sanitation

Colo., Ft. Collins—Until 8 a. m., July 8, by city of Ft. Collins for the construction of a $13,000 reinforced concrete settling basin, with 1,000,000 gal. capacity. (Advertisement in this issue.)

Ia., Dubuque—Until 2 p. m., June 30, by City Manager, Dubuque, Ia., for furnishing labor and material for the construction of approx. 1,540 ft. 6-in. sanitary sewer, 410 ft. 6-in. and 320 ft. of 4-in. sanitary sewer, 240 ft. 6-in. sewer in various streets.

La., Shreveport—Until 10 a. m., July 1, by city secretary-treasurer, City Hall, Shreveport, for the construction of a sanitary sewer line from end of present sewer to U. S. Window Glass Plant.

Mass., Boston—Until noon, June 29, by Jos. A. Burke, Commissioner of Public Works, 508 City Hall, Boston, for sewerage work in Washington St., between Auburn and Beech Sts., West Roxbury.

Mass., Milford—Until 8 p. m., June 30, by Sewer Commissioners, Town of Milford, for the construction of a sewage disposal plant. Chas. F. Cahill, Clerk. F. A. Barbour, 1120 Tremont Bldg., Engineer.

Mich., Ann Arbor—Until 7:30 p. m., July 13, by Fred G. Reynolds, City Clerk, for the construction of a lateral sewer. (Advertisement in this issue.)

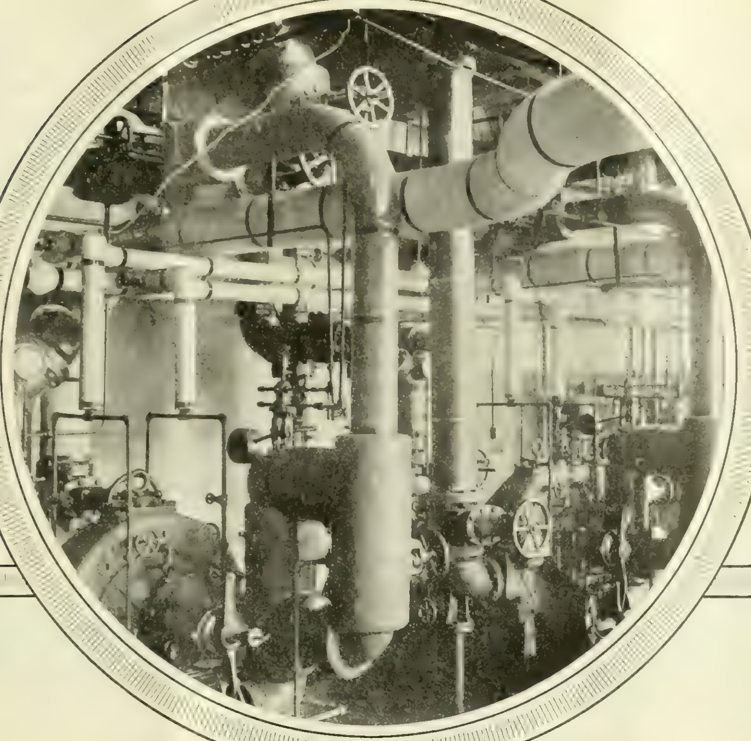
Minn., Belle Plaine—Until 3 p. m., June 29, by council of the Borough of Belle Plaine, for the construction of five blocks and [illegible] ft. of lateral sewer. Donald Childs, Engineer, Shakopee, Minn.

Minn., Graceville—Until 4 p. m., July 7, by J. J. O'Connor, village clerk, for the construction of a sanitary sewer system, including treating plant and all necessary laterals and appurtenances.

N. J., Bloomfield—Until 8 p. m., July 3, by Donald F. Peck, Town Clerk, for the improvement of Watsessing Ave. by construction of storm water sewer. Work will include repair of bit. pavement, 500 sq. yds.; installation of 1,200 lin. ft. 20-in. tile pipe, 100 ft. 20-in. cast-iron pipe, [illegible] ft. 18-in. tile pipe, 220 ft. 15-in. tile pipe, 340 ft. 12-in. tile pipe, 12 catch basins and [illegible] manholes.

N. Y., Syracuse—Until 1:30 p. m., July 3, by Board of Contract and Supply for furnishing material and labor for the construction of a pipe drain and concrete head walls across Comstock Ave., south of E. [illegible] St., city of Syracuse.

O., Cleveland—Until noon, June 29, by commissioner of purchases and supplies, R. [illegible] City Hall, for construction of a sewer, approximately 1,400 ft.



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O., Toledo—Until 10 a. m., July [illegible], by Board of County Commissioners of Lucas County, Court House, Toledo, for the construction of [illegible] ft. of sanitary sewer. [illegible] E. Schmitt, Clerk.

Wyo., Cheyenne—Until noon, June [illegible], by [illegible] City Clerk, City and County [illegible], for the construction of [illegible] sanitary sewer.

Buildings

Ariz., Flagstaff—Until 2 p. m., July 7, by board of trustees of Flagstaff High School Dist., for furnishing labor and materials for the erection and completion of a [illegible]. V. O. Wallingford, [illegible] Bldg., Phoenix, Ariz., and Norman F. Marsh, [illegible] Broadway Central Bldg., Los Angeles, Calif., architects.

Ariz., Mesa—Until 11 a. m., June 29, by W. S. [illegible], adjutant general of the State of Arizona, Capitol Bldg., Phoenix, Ariz., for the construction of a state armory at Mesa, Ariz. Lescher, Kibbey & [illegible], Archts., **Arizona Nat'l Bank** Bldg., Phoenix, Ariz.

Ariz., Phoenix—Until 10 a. m., June 29, by W. S. [illegible], adjutant general of the State of Arizona, Capitol Bldg., Phoenix, [illegible] construction of a state armory at Phoenix. [illegible] & Byron, Archts., 206 Home Builders Bldg., Phoenix, Ariz.

Calif., Berkeley—Until 4 p. m., June 29, by the board of education, [illegible], Sec., 2125 Allston Way, Berkeley, Calif., for furnishing materials and labor for the construction of shops at the [illegible] school. Walter H. Ratcliff, Archt., First National Bank Bldg., Berkeley, Calif.

Calif., El Monte—Until 2 p. m., July 1, by board of El Monte Union High School Dist., El Monte, for the erection of [illegible]-story brick manual training building. Edw. C. Thorne, Archt., 620 Mutual [illegible] Bldg., Los Angeles, Calif.

Conn., Hartford—Until 11 a. m., July 7, by Comptroller Harvey P. Bissell of State of [illegible], Capitol Bldg., Hartford, for the following named buildings for the State Tuberculosis Commission: A recreation [illegible] building, located at Hartford, Conn., a [illegible] room hall and housekeepers [illegible] at Meriden, Conn., a first floor [illegible] at Norwich, Conn., and a [illegible] **building at Niantic, Conn.**

Fla., Macclenny—Bids are being readvertised by the board of public instruction, county of Baker, for the erection of a brick and frame school building. Jefferson D. [illegible], Archt., Bisbee Bldg., Jacksonville, Fla.

Ill., Springfield—Until 2 p. m., July 1, by [illegible] of school district No. [illegible], for the addition of two rooms to the Highlands school. [illegible], Archt., 1231 [illegible] Ave., Springfield, Ill.

Ind., Ft. Wayne—Until 10 a. m., June [illegible], by [illegible] C. McC[illegible], Auditor, Allen County, Ft. Wayne, Ind., for constructing [illegible].

Ind., Ft. Wayne—Until 2 p. m., July ...., by [illegible], Trustee of Adams Twp., [illegible] Ft. Wayne, Ind., for the erection and completion of a [illegible] school building, [illegible] heating and electric wiring. [illegible] M. Meier, Archt., **615 W. Jefferson St.**, Ft. Wayne, Ind.

Ky., Louisville—Until 8 p. m., July [illegible], by board of education, [illegible] **tricity at** [illegible] school.

Mass., Boston—Until [illegible], June 30, by [illegible] **division of** [illegible]

Mass., Boston—Until [illegible], June 29, [illegible]

Mass., Northampton—[illegible]

Mass., Boston—[illegible]

Minn., Albert Lea—Until 3 p. m., July [illegible], by Jas. A. Wetmore, Acting Supervising Archt., Treasury Department, Washington, D. C., for alterations in post office building.

Minn., National Falls—Until 1:30 p. m., July 6, by Independent School Dist. No. 1, **Koochiching County, International Falls**, Minn., for furnishing labor and material for construction of a high school building. Tyrie & Chapman, Archts., 1200 Second Ave., Minneapolis, Minn.

N. J., Newark—Until 8:30 p. m., June 29, board of education of the town of Nutley, Park school building, Nutley, N. J., for furnishing labor and material for construction of a 10-room addition to the Park school **building, including plumbing,** heating, **ventilating and electrical work.** Chas. Granville Jones, Archt., 280 Broadway, New York City.

N. J., Newark—Until 8:15 p. m., July 12, by board of education, for repairs to roofs, gutters, etc., of various schools.

N. J., Newark—Until 2 p. m., July 7, by board of trustees of the Free Public Library **of Newark, 1-11 Washington St.,** Newark, **for construction of an addition** to and alteration of the library building. John H. & Wilson C. Ely, Archts., Firemen's Bldg., Newark, N. J.

N. Y., Cortland—Until 11 a. m., June 29, by special building committee of the board of supervisors, **40 Main St., Cortland, N.** Y., for plumbing, **electric work and elevator installation at new courthouse and jail.** Jas. R. Gordon, Archt., 507 Fifth Ave., New York City.

N. Y., Oswego—Until 3 p. m., June 19, by Jas. A. Wetmore, **Acting Supervising Archt., Treasury Department, for restoration** of stone cornices and replacing of roof, etc., **for U. S. post office and custom house.**

N. C., Lincolntown—Until 2 p. m., June 30, by Dr. I. R. Self, chairman of the **board of trustees, High School Bldg., Lin**colntown, N. C., for the erection of a high **school building. Jas. A. Salter, Archt., Raleigh, N. C.**

N. D., Litchville—Until 2 p. m., July 7, by J. L. Nelson, Clerk, for the erection and completion of a school building. W. D. Gillespie, Archt., Fargo, N. D.

Pa., Ambler—Until July 1, by **board of education, for construction of a high school building. S. S. Conover, Archt.**

Pa., Carbondale—Until 9 a. m., June 11, **by the Armory Board, Benj. W. Demming, Sec., Adjutant General's office, Harrisburg,** Pa., for the erection of a drill hall, State **Armory, Carbondale. Fred A. and John Nelson, Archts., Scranton, Pa.**

Pa., Geistown—Until 2 p. m., July 1, by D. S. Yoder, Sec., Richland twp. school dist., R. D. No. 3, Johnstown, Pa., for the erection **of a two-story brick school building, including system of heating, electric** wiring and plumbing. Hersch & Holler, Asso. Archts., **Commerce Bldg., Altoona,** Pa.

Pa., Philadelphia—Until July 6, by Board of Education, for the erection of Carroll school building.

Pa., Philadelphia—Until July 3, by Albert M. Greenfield, s. w. cor. 15th and Chestnut Sts., for the erection of a bank office build**ing and power house. Hoffman-Henon Co.,** Archts.

Pa., Philadelphia—Until noon, July 6, by **Bureau of Hospitals, 34th and Pine Sts., for** the erection of a residence building for internes, **including construction, plumbing,** heating and electrical work. Philip H. Johnson, Esq., Archts., **Presser Bldg., 1713** Sansom St., Philadelphia.

S. D., Dell Rapids—Until 11 a. m., July [illegible], by C. J. Bach, chairman, Odd Fellows' Home, for a two-story stone power house. Joseph **Schwarz, Archt., Sioux Falls, S. D.**

S. D., Trent—Until July 10, by Beuttler & Arnold, Archts., Sioux City, S. D., for the construction **of a $50,000 school building.**

Tex., Sherman—Until 7:30 p. m., July 1, by [illegible] M. Reynolds, Pres. School Board, Sherman, Tex., for the erection of a high school building. C. H. Page & Bro., Archts., Austin, Tex.

Tex., Taylor—Until 2 p. m., July 3, by board of school trustees, Taylor, Tex., for the erection of a high school building. [illegible] & Harris, Archts., Austin, Tex.

Ont., Inglewood—Until 5 p. m., July 4, by board of education, T. H. Graham, [illegible], Inglewood, Ont., for the erection of a [illegible] public school building.

Ont., Toronto—Until noon, July 4, by [illegible], Mayor and Chairman of Board of Control, by registered post only, for work in connection with the erection and completion of a Nurses' Home at Riverdale Park, work includes the following: Masonry, carpenter work, roofing and metal work, plumbing, steam heating, plastering and painting.

Rivers - Harbors

D. C., Washington—Until 2 p. m., July 11, by Commissioners, R. 509, District Bldg., Washington, D. C., for removing old piles and portions of pier and driving piles at **old ferry wharf on Water St.**

La., New Orleans—Until 11 a. m., July 17, at office of U. S. Engineer, 329 Customhouse, New Orleans, for constructing and delivering steel ladder, pipe, gears and [illegible] for U. S. dredge, "Gulfport."

La., New Orleans—Until noon, June 20, by board of commissioners of the Port of New Orleans, **for furnishing creosoted** piles, and creosoted timbers.

N. J., Elizabeth—Until 8 p. m., July 5, **by city council, city hall, for repairing and** rebuilding the dock at the foot of Elizabeth Ave.

N. Y., New York—Until noon, June 30, by Commissioner of Docks, Pier A, foot of Battery Pl., North River, Manhattan, for building a ramp and dumping board at the foot of W. 23d St., Coney Island Creek, Borough of Brooklyn, and dredging incidental thereto.

N. Y., New York—Until 11 a. m., Friday, June 30, **by Commissioner of Water Sup**ply, Gas and Electricity, R. 2351 Municipal Bldg., Manhattan, for furnishing and installing new pier lines and dock hydrants at Pier No. 5, Pier No. 33, East River, Pier No. 43, North River, and Pier No. 69, East River, and for replacing existing pier lines and dock hydrants at Pier No. 103, East River, and Pier No. 114, North River, Borough of Manhattan.

Power Plants

Ala., Dothan—Until 2 p. m., Aug. 15, by the mayor and city council of the city of Dothan, for constructing a hydro-electric project **with all appurtenances. (Advertisement in this issue.)**

Fla., Green Cove Springs—Until July 5, **by bond trustees, F. Lon. Robertson, Sec.,** for power house equipment to cost about $25,000.

Ill., Peoria—Until 2 p. m., July 3, by board of local improvements, R. 306, City Hall, for an ornamental street lighting system.

N. J., Perth Amboy—Until 7 p. m., July 3, by city council, city hall, A. E. Graham, city clerk, for one cylinder for oil injection end of engine **to be used on 360-hp.,** Bolinder type engine.

Miscellaneous

Ala., Tuskegee—Until 3 p. m., July 18, by Jas. **A. Wetmore, Acting Supervising** Architect, Treasury Department, Washington, D. C., for a fire alarm system at U. S. Veterans' Hospital.

Ga., Augusta—Until 3 p. m., June 19, by Jas. A. Wetmore, Acting Supervising Archt., Treasury Dept., **Washington, D. C.,** for furnishing wire grilles for U. S. Veterans' Hospital, Augusta, Ga. (Advertisement in this issue.)

Mich., Detroit—Until 10:30 a. m., June 30, by Detroit House of Correction, 1441 Alfred St., Detroit, for furnishing one only used horizontal **tubular boiler, 72 in. by 16** ft., **complete with boiler front.**

N. Y., Buffalo—Until 10 a. m., July 6, by commissioner, department of public safety, city **and county hall, Buffalo, for fur**nishing fire department with 9,000 ft. of [illegible] and 1,000 ft. of 3½ in. internal measurement, cotton woven rubber lined fire hose with couplings attached.

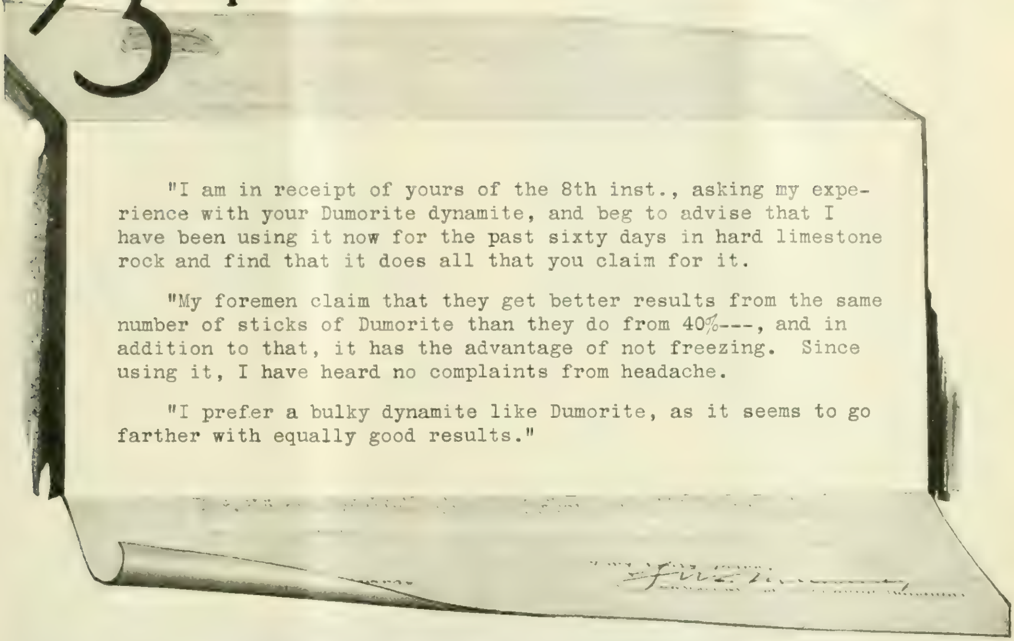
N. J., Midvale—Until 8 p. m., June 30, by O. L. Fleetwood, District Clerk, Midvale School, Midvale, Pa., for the installation of a toilet in public school.

O., Akron—Until noon, July 3, by purchasing agent, Akron, O., for furnishing [illegible] dump truck.

O., Cleveland—Until noon, June 30, at office of Commissioner of Purchases and Supplies, R. 19, City Hall, for trucks with dump bodies for hauling garbage; also for

1/3 more per dollar

The excerpt below is from a letter written by a large user of Dumorite for contracting operations.



"I am in receipt of yours of the 8th inst., asking my experience with your Dumorite dynamite, and beg to advise that I have been using it now for the past sixty days in hard limestone rock and find that it does all that you claim for it.

"My foremen claim that they get better results from the same number of sticks of Dumorite than they do from 40%---, and in addition to that, it has the advantage of not freezing. Since using it, I have heard no complaints from headache.

"I prefer a bulky dynamite like Dumorite, as it seems to go farther with equally good results."

O. K.d by the Severest Judges

NO ONE is better fitted to judge the value of an explosive than the contractors who shoot it.

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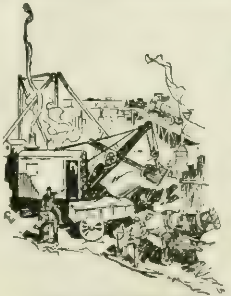

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Duluth	Minn.	San Francisco,	Calif.
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E. I. du Pont de Nemours & Co., Inc.
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Wilmington, Delaware

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DUMORITE

THE LATEST OF A COMPLETE LINE OF DU PONT EXPLOSIVES

[illegible] Water.

R. I., Providence—[illegible]

Railways

BIDS ASKED

Mass., Boston—[illegible]

Mich., Detroit—[illegible]

Mich., Detroit—[illegible] Niagara Falls, Canada.

N. Y., New York—[illegible]

O., Cincinnati—[illegible]

O., Cincinnati—The Cleveland, Cincinnati & St. Louis Ry. [illegible] Interstate Commerce [illegible] will receive bids up to noon July 5, [illegible] steel clips [illegible] rail to steel [illegible] 19 in. [illegible] Penn Steel [illegible] No. 12 [illegible] girder rail angle [illegible] brace [illegible] tie rods, 12 [illegible] nearest [illegible] C. C. C. & St. L. Ry. W. J. [illegible] Purchasing Agent, [illegible] W. 3rd St., Cincinnati, O.

PROSPECTIVE WORK.

Ariz., Phoenix—Bids for the [illegible] of [illegible] station will be [illegible] in a few [illegible] according to [illegible] Commissioner A. A. Betts. [illegible] call for a structure [illegible] $[illegible]

Ill., Mt. Vernon—According to Geo. F. [illegible] the [illegible] Nason [illegible] State [illegible] has granted a certificate of [illegible] permitting the construction of the Jefferson Southwestern R. R. from Mt. Vernon to a point 12 miles [illegible] in Elk Prairie twp.

Md., Baltimore—A delegation from the [illegible] Improvement Association will [illegible] United Railways to provide an [illegible] of the Harford Road car line [illegible] present terminus at Hamilton [illegible] to the old Harford road.

Md., Baltimore—The Pennsylvania R. R. is [illegible] bids for raising tracks and [illegible] line on the Northern Central Ry., [illegible] Phoenix, Md., work includes about [illegible] yds. excavation, 1,300 yds. masonry, [illegible] of track material to be unloaded [illegible] also [illegible] yds. ballast to be unloaded. J. W. Craig, Asst. Engineer, Baltimore, Md.

Md., Hagerstown—Pennsylvania asks [illegible] for the **completion of its engine terminal** [illegible] at Hagerstown. **W. K. Martin, Engr. of Const'n, Harrisburg, Pa.**

N. Y., Albany—Approval has been given by the Public Service Commission to plans for a new [illegible] of the Buffalo, Rochester & Pittsburgh R. R., on the Warsaw-Perry Center Federal Aid highway.

Okla., Oklahoma City—The Frisco R. R. [illegible] has been directed by the Corporation Commission to construct an underground crossing near Unger, Choctaw County, in connection with the completion of a Federal Aid project.

Pa., Philadelphia—Philadelphia Rapid Transit Co., Thos. E. Mitten, pres., has asked the city officials to provide **for construction** of extensions and high-speed facilities.

Tenn., Chattanooga—The Chattanooga Traction Company proposes to **extend its** Red Bank line **several miles up Dry Valley**. [illegible], Vice Pres. and G. M.

Tex., Byers—A survey is being made for the new Waurika extension of the Wichita Valley Ry.

Tex., Dallas—Steps have been taken by the Board of Commissioners, Dallas, Tex., to require the H. & T. C. R. R. Co. to elevate its tracks. Estimated cost to city of Dallas, $10,000.

Tex., Austin—The Missouri, Kansas & Texas Ry. has received permission from the Railroad Commission to dismantle its present shops and roundhouse at Denison and to construct new ones on a site adjacent to **Denison, called Ray Yards**. Estimated cost, $3,000,000.

Utah, Salt Lake City—General improvements to cost $1,690 will be undertaken immediately on the Oregon Short Line R. R., according to information received by E. A. Flatt, General Manager. Work includes **double tracking** through Glens Ferry, additional trackage in yards at Nampa, additional trackage at Soda Springs and additional trackage and improved shop equipment in Salt Lake City yards.

Wash., Deer Park—Merk F. Mendenhall, Sr., president of the Mount Spokane Power Co., Deer Park, has made application to the public service **commission for a franchise to operate an electric railway bet.** Deer Park, Clayton and Loon Lake to **Springdale.**

Wash., Olympia—The Wenatchee Southern Ry. has made application to the **Interstate Commerce Commission for permission to build a line connecting Wenat**chee and Orondo, Wash.

Wyo., Casper—The Burlington Ry. Co. is making surveys for a railway line to the Salt Creek and Teapot oil fields, 45 mi. north of Casper, Wyo. **Harry F. Sinclair,** Mammoth Oil Co., interested in project.

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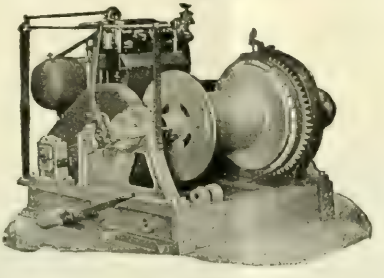

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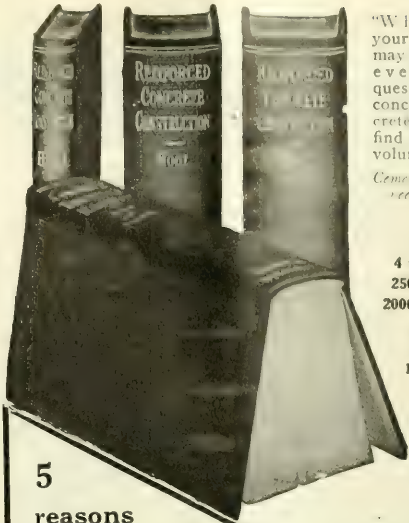

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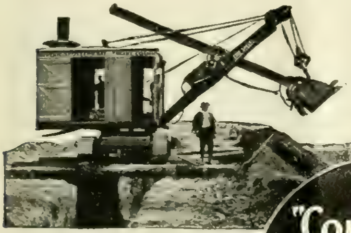

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"Could not be better for trench excavation"

"We have used many shovels, but like the ERIE best. It couldn't be better for trench excavation. It is on the job all the time, turning out a good big yardage.

"We have found the ERIE a mighty satisfactory investment, not only for trench excavation, but also for road grading and rock work."—*Arthur S. Bent, Bent Bros., Los Angeles, Calif.*

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CALLS FOR BIDS

Copy received
until
Monday noon

[illegible] received until July [illegible], 1922

DEPARTMENT OF PUBLIC WORKS.

Buffalo, N. Y., June [illegible], 1922.

Sealed proposals will be received at the office of this department, Room 9, Municipal Building, until 11:00 o'clock, July [illegible], 1922, for the following:

1st. For a tract of land not less than [illegible] acres [illegible] adjoining a railroad and within [illegible] miles of the Buffalo City Line, for the operation and maintenance of a [illegible]. Bidders must give a full description of the property, price per acre or terms [illegible] for a period of years subject [illegible] by the city and also to the city the right to purchase the same at the price mentioned in said bid for a period of six months from the date of the opening of such bid.

2nd. For a tract of land not less than 10 acres adjoining a railroad and not over [illegible] miles from the Buffalo City Line, for the operation and maintenance of an incineration or reduction plant. Bidders must give a full description of the property, price per acre or terms for a lease for a period of years subject to purchase by the city and give to the city the right to purchase the same at the price mentioned in said bid for a period of six months from the date of the opening of such bid.

3rd. For the necessary machinery and equipment for the incineration or reduction of all garbage collected by the City of Buffalo which machinery and equipment must have a capacity of 200 tons per day. Bidders must submit detailed plans and specifications showing their method of incineration or reduction, including the cost of operation per ton, the commercial value of the residue, the names of cities where similar plants are being operated and a guaranty that no obnoxious gases or odors will be created through operation. No proposal will be considered unless it be accompanied by a certified check, payable to the order of the Department of Public Works, in an amount equal to ten per cent of the cost of said machinery and equipment or a bond in conformity with law which bond shall be fifty per cent of the sum named in the proposal.

4th. For the necessary machinery and equipment for the incineration or reduction of some of the garbage of the City of Buffalo which said machinery and equipment must have a capacity of at least 50 tons per day. Bidders must submit detailed plans and specifications showing their method of incineration or reduction, including the cost of operation per ton, the commercial value of the residue, the names of cities where similar plants are being operated and a guaranty that no obnoxious gases or odors will be created through operation. No proposal will be considered unless it be accompanied by a certified check payable to the order of the Department of Public Works in an amount equal to ten per cent of the cost of said machinery and equipment or a bond in conformity with law which bond shall be fifty per cent of the sum named in the proposal.

Any desired information in regard to the above can be had on application at the office of the Commissioner of Public Works, Room 9, Municipal Building on and after this date.

The department reserves the right to reject any and all bids and waive any informalities.

The above [illegible] requested pursuant to [illegible] of the City of Buffalo [illegible] day of May, [illegible].

ARTHUR W. KREINHEDER,
Commissioner of Public Works, City of Buffalo.

June [illegible] 26, 27

U. S. ENGINEER OFFICE, P. O. Box [illegible], Louisville, Ky. Sealed proposals will be received here until 2 P. M. Central Time, July [illegible], 1922, and then opened, for [illegible] and delivering [illegible] for Dam No. 41, Ohio River. Further information on application.

Bids received until July 6th, 1922

NOTICE TO CONTRACTORS.

Grade Separation File No. [illegible]
and
Federal Aid Road No. 35, Section F, on
Trunk Line Route No. 17, in Leoni
Township, Jackson County,
Michigan

Jackson, Mich.

Sealed proposals will be received at the office of the Board of County Road Commissioners of Jackson County, 132 N. Ganson St., Jackson, Michigan, until 1:00 P. M. Central Standard Time, Thursday, July 6, 1922, by Frank F. Rogers, State Highway Commissioner, for

Group A—Improving .296 miles of road in Leoni Township, Jackson County, Michigan, at the East limits of the Village of Leoni, and known as Section F of Federal Aid Project No. 35.

Group B—Construction of Substructure for an undercrossing passing under the Michigan Central Railroad Company's tracks at a point about midway in the above project.

DESCRIPTION OF WORK.

Group "A."—This group is to include all earthwork in the project exclusive of that portion between stations 160-70 and 161-00 which is included under Group "B." Approximately 15,442 cu. yds. of excavation and 616 cu. yds. of fill is involved.

Disposition of all waste material of the entire project is included under Group "A." Waste material is to be used for forming a temporary road, and surplus material is to be disposed of in the mill pond as shown on the plans, and as may be further directed by the Engineer.

Group "A" also includes the removal of an existing culvert and the construction of a new concrete slab culvert requiring about 80.4 cu. yds. of concrete and 1,926 lbs. of reinforcing steel.

Group "B."—The following work is included under this group:

(a) Masonry.—The construction of two plain concrete abutments for the proposed undercrossing. Approximately 1,406 cu. yds. of Grade C concrete and 20,600 lbs. of reinforcing steel is involved.

(b) Drainage.—The construction of the main drain from the subway to outlet, including connecting surface drains and abutment drains. This item includes about 1,040 lin. ft. of 12-in. vitrified tile, 334 lin. ft. of 8-in. vitrified tile, 8 inlets and 2 manholes.

(c) Earthwork.—Includes all excavation and backfill, with free overhaul, between Stations 160-70 and 161-00.

Falsework.—Is now being placed by the M. C. R. R. and will be removed by the Railorad Company when the superstructure is erected.

Right of Way and Water Difficulties.—All right of way, and flowage rights in connection with the mill pond adjacent to site, and all land and property damages have been taken care of and mill pond control will be turned over to the contractor. Gates to the dam will be opened prior to the award of this contract.

Soil Conditions—Indications are that material is a silty or clay gravel for full depth of excavations. Contractors must assure themselves of this however. It is not probable that piles will be required, although a unit price will be taken to cover this item.

Superstructure is not a part of the proposed contract.

Paving and Curb and Gutter are not included in this work.

Groups A and B will necessarily be awarded to one party, but with the provision that contractor may sublet the work of grading if he so desires, subject to the written approval of the State Highway Commissioner. The concrete mixes called for in the bridge plans are to be slightly modified to meet Highway Specifications. All cement on this work will be furnished by the State Highway Departments F. O. B. cars Leoni. All work on this contract in both Groups A and B must be completed on or before December 1st, 1922.

Plans, specifications and proposal blanks may be received by writing the undersigned and forwarding with application the sum of $5.00 as deposit, this amount being refunded on return of these plans in good condition. Plans may be examined at the office of the County Road Commission at Jackson, at the District office of the State Highway Department, Ann Arbor, or at the office of the State Highway Department, Lansing, Michigan. A certified check in the amount of $500 is required with all proposals.

FRANK F. ROGERS,
State Highway Commissioner.
Lansing, Michigan, June [illegible], 1922.

BIDS FOR CONSTRUCTION OF CURB AND GUTTERS AND SEWERS.

Ann Arbor, Mich.

Sealed proposals will be received by the Board of Public Works, Ann Arbor, Michigan, through the City Clerk, on or before 7:30 p. m., Eastern Standard Time, July 14, 1922, for the construction of concrete curb and gutter in curb and gutter districts Nos. 24 to 49, inclusive, also for the construction of lateral sewer in Lateral Sewer District No. 112 and for a storm sewer on Brooks St., from Pearl St. to Miller Ave. Approximate quantities are as follows:

53,200 lin. ft. combined curb and gutter.
680 lin. ft. 10-in. vitrified pipe.
1,200 lin. ft. 12-in. vitrified pipe.
1,240 lin. ft. 15-in. vitrified pipe.
250 lin. ft. 18-in. vitrified pipe.
180 lin. ft. 22-in. vitrified pipe.

2,000 cu. yds. excavation and backfilling.

Plans and specifications are on file in the City Engineer's office. A certified check for 5% of the bid must accompany each bid as guarantee of good faith of bidder and the Board of Public Works reserves the right to reject any and all bids.

ISAAC G. REYNOLDS,
City Clerk.

Bids received until 12 M. July 7, 1922

SEWAGE TREATMENT PLANT.

Geneva, Ohio.

Sealed bids will be received until noon July 7, 1922, by the Village of Geneva, Ohio, for constructing a Sewage Treatment Plant and Pumping Station. Plans and specifications from Burgess and Niple, Columbus, Ohio, on receipt of ten dollars, of which five dollars will be refunded.

W. E. MORGAN,
Village Clerk.

TREASURY DEPARTMENT, Office of the Supervising Architect, Washington, D. C., June 14, 1922.—SEALED PROPOSALS will be opened in this office at 3 p. m., July 14, 1922, for alterations to the United States Post Office at Lowell, Mass. Drawings and specifications may be obtained from the Custodian at Lowell, Mass., or at this office in the discretion of the Supervising Architect. Jas. A. Wetmore, Acting Supervising Architect.

TREASURY DEPARTMENT, Supervising Architect's Office, Washington, D. C., June 24, 1922.—SEALED PROPOSALS will be opened in this office at 3 p. m., July 20, 1922, for construction of new mailing shed at United States Post Office, Sheboygan, Wis. Drawings and specifications may be obtained from the Custodian at the building or at this office, in the discretion of the Supervising Architect. Jas. A. Wetmore, Acting Supervising Architect.

U. S. ENGINEER OFFICE, P. O. Box 7[illegible], Louisville, Ky. Sealed proposals will be received here until 2 p. m., Central Time, July 17, 1922, and then opened, for furnishing and delivering Metal Work for Navigable Pass for Dam No. 41, Ohio River. Further information on application.

U. S. ENGINEER OFFICE, Buffalo, N. Y. Sealed proposals will be received here until 11 a. m. (Standard time), July 17, 1922, and then opened, for constructing rubble mound extension of west breakwater, Ashtabula Harbor, O. Further information on application.

CALLS FOR BIDS ON PAGES 32 AND 34.

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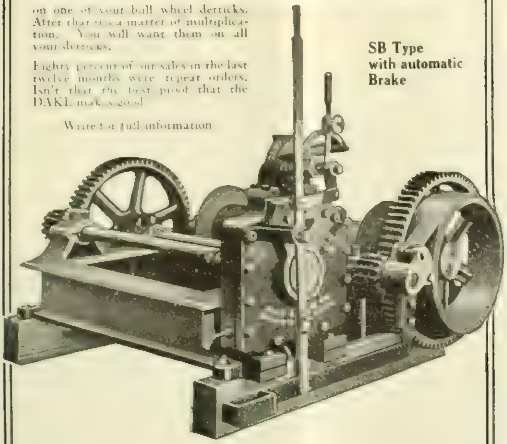

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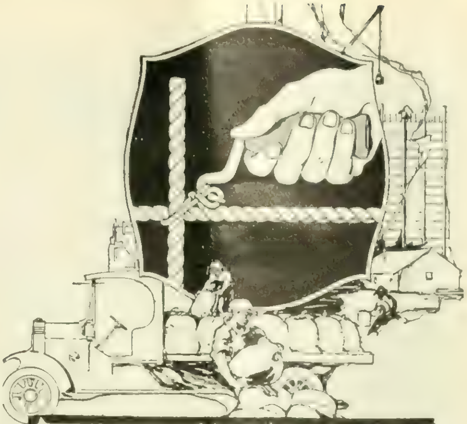
DAKE ENGINE CO., Grand Haven, Mich.

New York: H. L. DRULLARD, 30 Church St.
Chicago: J. E. CHISHOLM & CO., Ltd., 810 Monadnock Block



THEY USED BATES WIRE TIES by the million on the King Hill (Idaho) Project of the U. S. Reclamation Service. Nine and one-half miles of reinforced concrete flume were built with a Bates Wire Tie holding fast every intersection. Reports of the work say that in placing the reinforcing steel in forms it was possible to do the job three times as fast by using wire ties and tying tools—instead of ordinary pliers and straight wire.

FREE TRIAL OUTFIT—The Bates FREE Trial Rod Tying Outfit consisting of one Pistol Grip Tying Tool as illustrated above and liberal samples of the various sizes of wire ties will be sent on receipt of your signed agreement to try it on your work and within fifteen days send us $1.00 or return the tool, These trial ties cost you NOTHING.

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Write today for new catalogue No. 70 showing especially the 4-S, 7-S and 10-S sizes.

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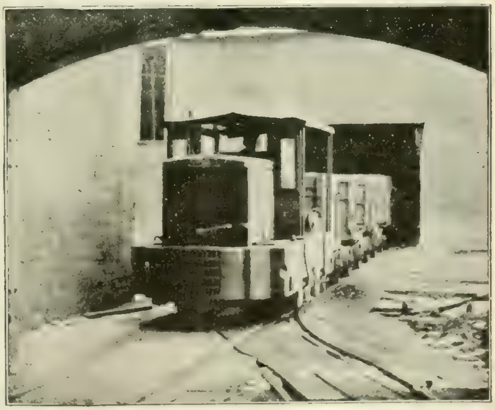
Milwaukee, Wisconsin



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CALLS FOR BIDS

Copy received until Monday noon

HYDRO-ELECTRIC PROJECT.

Dothan, Ala.

Sealed proposals will be received by the Mayor and City Council of the City of Dothan, Alabama, until 2 o'clock P. M., Tuesday, August 1, 1922, for constructing a Hydro-Electric Project with appurtenances, including materials and equipment, at High Bluff on the [illegible] River about six miles from Dothan, Ala., in sections 3 and 4 of township 2 N., range 25, Geneva County, Alabama. The work consists of the construction of an earth dam, a concrete spillway, abutments, a power house, and the furnishing and installing of machinery.

The principal approximate quantities involved are the following:

[illegible] cu. yds. of excavation.

[illegible] cu. yds. of embankment.

18,[illegible] cu. yds. of concrete of different classes.

[illegible] pounds of reinforcing steel.

[illegible] pounds of structural steel work.

Turbines, generators, transformers and auxiliary power house equipment for a present installation of approximately 3,000 BHP capacity in two units.

A transmission line twenty-one and one-half (21½) miles long at 44,000 volts pressure.

Plans and specifications are on file at the office of the City Clerk, at Dothan, Alabama, and at the office of The Ludlow Engineers at Winston-Salem, N. C., where they may be examined by prospective bidders.

Copies of the plans covering the construction details of this project and two copies of the specifications attached to the form of proposal and contract will be furnished by The Ludlow Engineers, Winston-Salem, N. C., upon application by prospective bidders accompanied by a check for twenty-five ($25.00) dollars to cover the cost of separate prints and extra copies of specifications and form of proposal, etc., at one ($1.00) dollar each.

Each bid must be accompanied by a certified check for approximately five (5%) per cent of the bid.

Proposals will be received at the City Hall, Dothan, Alabama, and opened publicly with the right reserved to accept any bid or to reject any or all bids as the best interests of the City may appear.

Plans and supervision by THE LUDLOW ENGINEERS, INC., Winston-Salem, N. C.

E. O. JONES, Mayor.
F. W. LISENBY, City Clerk.

COUNTY ROAD WORK.

Geneva, Ill.

1. Notice is hereby given that sealed proposals for County Road Work in Kane County, said road work known as Section V-[illegible] and Section X-[illegible] on Route No. [illegible], will be received by the County of Kane at the office of the County Superintendent of Highways in the Court House at Geneva, Illinois, until 2 o'clock P. M., Wednesday, July 12th, A. D. 1922, at which time and place said proposals will be publicly opened.

2. Detailed information of the work to be done may be had by an examination of the plans and specifications on file in the office of the County Superintendent of Highways of Kane County.

3. The County Board of Supervisors reserves the right to reject any or all proposals and to waive technicalities.

4. The engineer's estimate of the proposed work is Thirty-seven thousand, nine hundred [illegible] ($37,[illegible]) dollars for Section V-[illegible] and Ten thousand six hundred eighty-eight and [illegible] ($10,688.[illegible]) dollars.

Dated June 21, 1922.

THE COUNTY OF KANE,
[illegible] L. Hanson,
County Superintendent of Highways.

U. S. ENGINEER OFFICE, 276 Old Land Office Building, Washington, D. C.—Sealed proposals will be received here until 12 M., [illegible] and then opened for the [illegible] of Item a, Item b, Section No. 1, Item b, Section No. 2 and Item c, [illegible] Section No. 1, Section No. 2 and [illegible] of the water supply conduit [illegible] District of Columbia. Further information on application.

Bids received until July 11th, 1922.

CONCRETE FILTER PLANT SUBSTRUCTURES.
CONTRACT NO. 1.

Buffalo, N. Y.

Sealed proposals for the construction of a coagulating basin, clear water reservoir, filter boxes, substructure of pumping station, conduits and other appurtenances in connection with the filter plant for the City of Buffalo, N. Y., will be received by the Commissioner of Public Works at his office in the Municipal Building, Buffalo, N. Y., until eleven a. m., daylight saving time, on Tuesday, the eleventh day of July, 1922.

Copies of the plans and specifications may be seen at the office of the Engineer of the Filtration Division, Bureau of Water, Porter Avenue, Buffalo, N. Y., and copies of the plans, specifications, contract and form of proposal may be obtained at this office upon the deposit of $25.00 for each set furnished, which sum will be refunded if the plans and specifications are returned within 30 days after bids have been received and acted upon. Plans and specifications may also be seen at the office of Fuller & McClintock, Consulting Engineers, 170 Broadway, New York.

Proposals must be made on the blank forms furnished and must be sealed and endorsed "Proposal for Filter Plant Substructures." Each proposal must be accompanied by a certified check in the amount of $150,000.00.

The principal estimated quantities are approximately as follows:

Earth excavation, 350,000 cu. yds.

Earth embankment, 110,000 cu. yds.

Rock excavation, 7,000 cu. yds.

Concrete masonry, 50,000 cu. yds.

Steel reinforcement, 3,500 tons.

Placing piping and iron and steel work by the City, 580 tons.

The principal structures are a reinforced concrete coagulating basin about 304 ft. x 408 ft. x 26 ft. average depth, a reinforced concrete clear water reservoir 330 ft. x 510 ft. x 25 ft. average depth and 40 reinforced concrete filter boxes each about 33 ft. x 50 ft. x 9 ft. deep.

The work is located in the City of Buffalo, on the water front south of Jersey Street.

The City reserves the right to reject any or all bids in case this is deemed to be for the interest of the City.

GEORGE C. ANDREWS,
Engineer, Filtration Division.

REINFORCED CONCRETE SETTLING BASIN.

Ft. Collins, Colorado.

The city of Ft. Collins, Colorado, will receive, until eight o'clock a. m., July 8, 1922, sealed proposals for construction of $13,000 reinforced concrete settling basin with 2,000,000 gallons capacity.

CITY ENGINEER,
Ft. Collins, Colo.

TREASURY DEPARTMENT, Supervising Architect's Office, Washington, D. C., June 19, 1922.—SEALED PROPOSALS will be opened in this office at 3 p. m., July 5, 1922, for furnishing wire grilles for the U. S. Veteran's Hospital, Augusta, Ga., in accordance with the specifications and drawings listed in same, which may be obtained from J. M. Geary, Superintendent of Construction, at the Hospital site, or from this office, in the discretion of the Supervising Architect. Jas. A. Wetmore, Acting Supervising Architect.

PROPOSALS FOR STEEL LADDER, PIPE, ETC.—U. S. Engineer Office, 329 Customhouse, New Orleans, La.—Sealed proposals will be received here until 11 a. m., July 17, 1922, and then opened, for constructing and delivering steel ladder, pipe, gears and shafting for U. S. Dredge "Gulfport." Further information on application.

U. S. Engineer Office, Pittsburgh, Pa. Sealed proposals will be received here until 12 noon (Eastern time), July 19, 1922, and then opened, for furnishing and delivering one steel derrick boat hull. Further information on application.

CONCRETE FLOOD GATE AND APPURTENANCES.

Little Rock, Arkansas.

Sealed proposals will be received by the Secretary of the Farelly Lake Levee District at the Marion Hotel, Little Rock, Arkansas, until 2:00 P. M., Tuesday, July 18th, 1922, for the construction of a Concrete Flood Gate and Appurtenances at Big Bayou Meto, Gillett, Arkansas County, Arkansas. Following are the aproximate quantities:

Excavation, 50,000 cu. yds.

Round Foundation Piles, 21,000 lin. ft.

Steel Sheet Pile Cut Off Walls, 20,000 sq. ft.

Concrete, 6,500 cu. yds.

Reinforcing Steel, 200 tons.

Gates and Accessories, 150 tons.

Hand Rail, 2 in. GI Pipe and Fittings, 1,500 lin. ft.

Hand Rail, 1½ in. GI Pipe and Fittings, 1,000 lin. ft.

Hoisting Apparatus, 30 tons.

Detail Plans, specifications and Blank Forms of Proposal are on file at the office of A. W. Dobyns, Attorney, Little Rock, Arkansas, and at the office of Ayres & Miller, McCall Building, Memphis, Tennessee.

Detail Plans, Specifications and Proposal Forms will be furnished upon application accompanied by a certified check for twenty ($20.00) dollars.

Each proposal shall be accompanied by a certified check for fifteen thousand ($15,000.00) dollars, made payable to the Secretary of the Board.

This check is to be conditioned that, if the bid is accepted, a contract will be entered into and the performance of same secured within ten (10) days after notification of acceptance of bid. Successful bidder will be required to furnish a surety bond in an acceptable surety company in the sum of fifty (50%) per cent of the contract price.

The right is reserved to reject any or all bids and to waive any technical defects, as the interests of the district may require.

The Engineres, or their assistants, will be at Gillett, Arkansas, from July 10th to July 15th to show prospective bidders over the work.

JOHN M. GRACIE, Chairman.
Board of Commissioners.
J. B. QUINN, Secretary,
Gillett, Arkansas.
AYRES & MILLER, Engineers,
McCall Building, Memphis, Tenn.

Bids received until July 1st, 1922.

NOTICE TO CONTRACTORS.

Pontiac, Mich.

Until 10 A. M., July 1st, for one deck girder four span length 250 ft., total concrete, 1,073.6 yards; total reinforcing steel, 122,890 pounds. Plans and more detailed information may be had by writing to George F. Burch, State Bridge Engineer, Department of Public Works and Buildings, Division of Highways, Springfield, Illinois. A certified check of ten per cent will be required with all bids.

Bids received until July 19, 1922.

NOTICE TO CONTRACTORS.

New Orleans, La.

Sealed proposals will be received by the Sewerage and Water Board of New Orleans, up to 12 o'clock noon, Wednesday, July 19th, 1922, for furnishing one 6,000 k.w. Turbine and accessories.

Specifications and blank forms of proposals may be obtained at room 303, No. 526 Carondelet Street, New Orleans.

The right is reserved to reject any or all bids.

GEO. G. EARL, General Supt.
A. G. MOFFAT, Secretary.

Proposals for 4 Diesel Electric Seagoing Hopper Dredges—Office, Chief of Engineers, Room 2802 Munitions Bldg., Washington, D. C. Sealed proposals will be received here until 12 o'clock noon, August 2, 1922, and then opened, for the construction of 4 Diesel Electric Seagoing Hopper Dredges. Further information on application.

CALLS FOR BIDS ON PAGES 32 AND 34.

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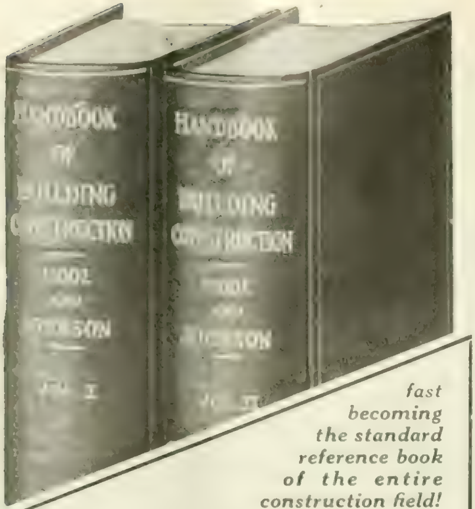
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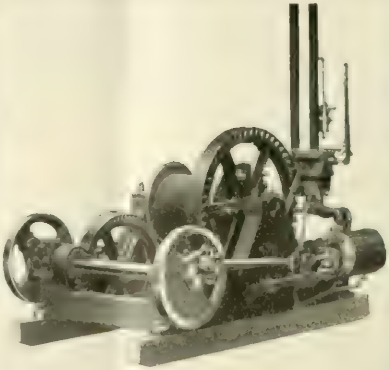

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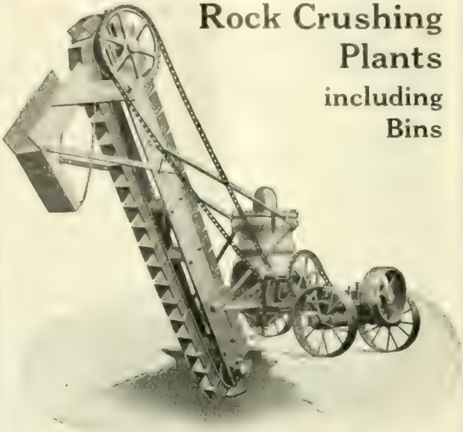

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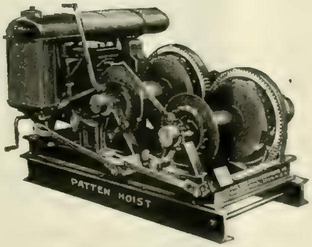

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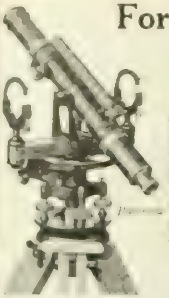

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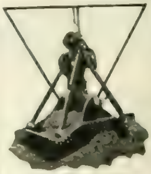

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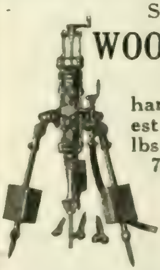

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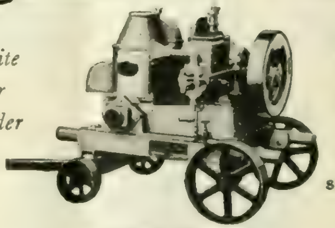

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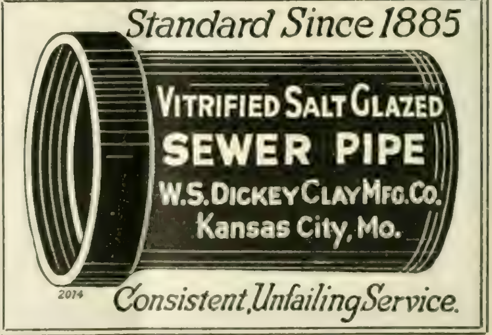

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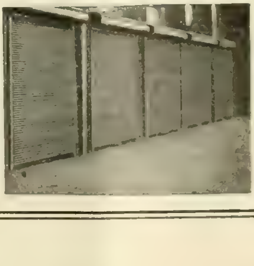

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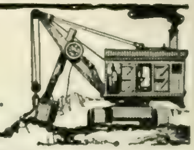

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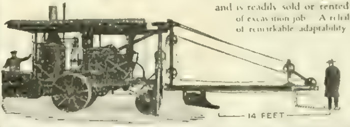

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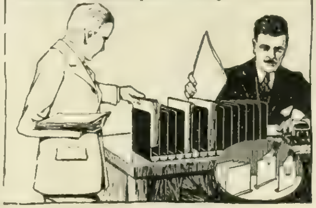

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  - Connery & Co., Inc.
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  - Ingersoll-Rand Co.
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  - Erie Steam Shovel Co.
  - Industrial Works.
  - McMyler Interstate Co.
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  - Northwest Engineering Co.
  - Orton & Steinbrenner Co.
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  - Penn Bridge Co.
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  - Bay City Dredge Works.
  - Penn Bridge Co.
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  - McMyler Interstate Co.
  - Pawling & Harnischfeger Co.
  - Penn Bridge Co.
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  - American Sheet & Tin Plate Co.
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  - California Corr Culv Co.
  - Canton Culvert & Silo Co.
  - Dixie Culvert & Metal Co
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  - Highway Iron Products Co
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  - Kentucky Culvert Mfg. Co.
  - Klauer Mfg. Co
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  - Lyle Corr. Culvert Co
  - Maryland Cu. & Metal Co.
  - Nebraska Cu. & Mfg. Co.
  - Nevada Metal Mfg. Co.
  - New Eng. Metal Culv. Co
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Edwards, C. D., Mfg. Co.
Good Roads Mach. Co., Inc.
Russell Grader Mfg. Co.
Smith & Sons Mfg. Co.
Shaw-Enochs Tractor Co.
Stockland Road Mach. Co.
T. L. Smith Co., The
Western Wheeled Scraper Co.
Scrapers—Drag and Wheeled.
Adams, J. D., & Co.
Austin-Western Road Machinery Co.
Baker Mfg. Co.
Edwards, C. D., Mfg. Co.
Good Roads Mach. Co., Inc.
Green, L. P.
Kilbourne & Jacobs Mfg. Co.
Pawling & Harnischfeger Co.
Smith & Sons Mfg. Co.
Shaw-Enochs Tractor Co.
Sauerman Bros.
T. L. Smith Co., The.
Western Wheeled Scraper Co.
Screens, Sand, Gravel, Etc.
Acme Road Mach. Co.
Austin Mfg. Co.
Beach Mfg. Co.
Good Roads Mach. Co., Inc.
Link Belt Co.
Smith Engineering Works.
Stockland Road Mach. Co.
Weller Mfg. Co.
Sewage Ejectors.
Economy Pumping Mach. Co.
Yeoman's Bros. Co.
Sewer Cleaning Machines.
Champion Corporation.
Turbine Sewer Machine Co.
Sewer Inlets.
Klauer Mfg. Co.
Shafting Equipment.
Weller Mfg. Co.
Shovels (See Steam Shovels).
Shoveling Machines.
Myers-Whaley Co.
Skylights.
Silos.
Dickey, W. S., Clay Mfg. Co.
Slag.
Carnegie Steel Co.
Sleeves Tapping (and Valves)
Crane Co.
Rensselaer Valve Co.
Smoke Stacks (See Steel—Structural).
Snow Plows.
Avery Company.
Baker Mfg. Co.
Edwards, C. D., Mfg. Co.
Good Roads Mach. Co., Inc.
Haiss, Geo., Mfg. Co.
Russel Grader Co.
Phoenix Mfg. Co.
Spreaders.
Austin-Western Road Machinery Co.
Western Wheeled Scraper Co.
Sprinkling Wagons, Flushers.
Acme Road Mach. Co.
Austin-Western Road Machinery Co.
Kinney Mfg. Co.
Reinforcing Concrete Accessories.
Concrete Engineering Co.
Truscon Steel Co.
Tiffin Wagon Co.
Waterloo Construction Co.
Western Wheeled Scraper Co.
Rolling Steel Doors.
Kinnear Mfg. Co.
Moeschl-Edwards Corrugating Co.
Milwaukee Corrugating Co.
Steam Shovels.
Austin Machinery Corp'n.
Ball Engine Co.
Bucyrus Co., The.
Erie Steam Shovel Co.
Keystone Driller Co.
Marion Steam Shovel Co.
Osgood Co., The.
Thew Automatic Shovel Co.
Steel, Hot Rolled Strips.
Laclede Steel Co.
Steel—Reinforcing Concrete.
Carnegie Steel Co.
Concrete Engineering Co.
Highway Iron Products Co.
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Laclede Steel Co.
National Steel Fabric Co.
Ryerson, Jos. T., & Son.
Truscon Steel Co.
Waterloo Construction Co.
Steel — Structural Work, Plates and Sheets, Etc.
American Sheet & Tin Plate Co.
Blaw-Knox Co.
Bucyrus Company.
Carnegie Steel Co.
Chicago Bridg. & Iron Wks.
Connery & Co., Inc.
Honhorst Co., Jos.
Inland Steel Co.
Klauer Mfg. Co.
Laclede Steel Co.
Memphis Steel Const. Co.
National Steel Products Co.
Pittsburgh - Des Moines Steel Co.
Ryerson, Jos. T., & Son.
Steel Sash.
Truscon Steel Co.
Steel Smokestacks.
Blaw-Knox Co.
Heil Co., The.
Honhorst, Jos., The, Co.
Littleford Bros.
Barnes Mfg. Co., The.
Stone Spreaders (See Spreaders).
Street Cleaning Machinery.
Austin-Western Road Machinery Co.
Baker Mfg. Co.
Universal Road Mach. Co.
Switches—Electric.
Tampers—Power.
Austin Machinery Corp'n.
Domestic Eng. & Pump Co.
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Chicago Pneumatic Tool Co.
East Jersey Pipe Co.
Ingersoll-Rand Co.
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Chicago Bridge & Iron Co.
Connery & Co., Inc.
Dickey, W. S., Clay Mfg. Co.
Heil Co., The.
Honhorst, Jos., The, Co.
Littleford Bros.
National Steel Products Co.
Pittsburgh - Des Moines Steel Co.
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Chain Belt Co.
Haiss Manufacturing Co.
Lee Loader Co.
Link Belt Co.
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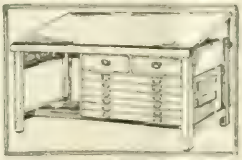

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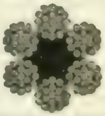

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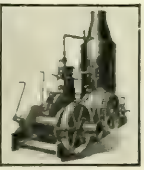

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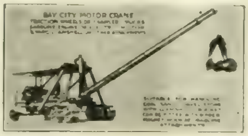

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